2.4 Energy

This chapter discusses the energy impacts of implementing transportation improvements in the proposed Transportation 2030 Plan. Issues related to energy use include levels of consumption of non-renewable energy sources for construction of transportation projects and private and commercial transportation.

Transportation energy use is related to the following factors: the efficiency of cars, trucks and public transportation; choice of different travel modes (auto, carpool, and public transit); and miles traveled by these modes. Energy is also consumed with construction and ongoing and routine operation and maintenance of the transportation infrastructure.

Also, because of concerns with increasing concentrations of greenhouse gases in the atmosphere, such as carbon dioxide, this chapter discusses global warming as well.

ENVIRONMENTAL SETTING

PHYSICAL SETTING

Energy Types and Sources

Petroleum products supply approximately 39 percent of the energy demand in the U.S. (Energy Information Administration, 1999). Coal and natural gas each supply approximately 23 percent of the national energy demand, and nuclear and renewable sources supply the rest in roughly equal proportions.

Petroleum and natural gas supply most of the energy consumed in California. Petroleum products provide approximately 50 percent of the state's energy demand, and natural gas provides approximately 29 percent (California Energy Commission (CEC), 2002). The remaining 21 percent of the state's energy demand is met by a variety of energy resources, including coal, nuclear, geothermal, wind, solar, and hydropower.

California's transportation sector, including on-road and rail transportation, consumes roughly two quadrillion (million billion) British thermal units (Btu)1 of energy annually; two quadrillion Btu are equal to 940 thousand barrels of oil consumed every day for 1 year (there are approximately 42 gallons in a barrel). The energy consumed by transportation modes accounts

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[1] The units of energy used in this report are British thermal units (Btu), kilowatt-hours (kWh), therms, and gallons. A Btu is the quantity of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at sea level. Since the other units of energy can all be converted into equivalent British thermal units, the Btu is used as the basis for comparing energy consumption associated with different resources. A kWh is a unit of electrical energy, and one kWh is equivalent to approximately 10,200 Btu, taking into account initial conversion losses (i.e., from one type of energy, such as chemical, to another type of energy, such as mechanical) and transmission losses. Natural gas consumption typically is described in terms of cubic feet or therms; 1 cubic foot of natural gas is equivalent to approximately 1,050 Btu, and 1 therm represents 100,000 Btu. One gallon of gasoline/diesel is equivalent to approximately 140,000 Btu, taking into account energy consumed in the refining process.

for roughly 60 percent of California's petroleum demand and 40 percent of the carbon dioxide emission fuel (CEC, 1999).

Petroleum

Most gasoline and diesel fuel sold in California for motor vehicles is refined in California to meet state-specific formulations required by the California Environmental Protection Agency's Air Resources Board. Major petroleum refineries in California are concentrated in three counties: Contra Costa County in northern California, Kern County in central California, and Los Angeles County in southern California. Valero, Tesoro, Phillips, Shell and Chevron operate refineries in Contra Costa County.

In 2002, refineries in California processed approximately 661 million barrels of crude oil (CEC, 2003b). Nearly one-half of the crude oil came from in-state oil production facilities; approximately one-fifth came from Alaska; and the remainder (approximately 30 percent) came from foreign sources. Together the refineries in the Bay Area have a crude oil processing capacity of 767,450 barrels per day. The long-term oil supply outlook for California indicates that in-state and Alaska supplies are declining, leading to increasing dependence on foreign oil sources.

Gasoline consumption for the nine Bay Area counties, during the last three years, is shown in Table 2.4-1. Caltrans estimates that 3.4 billon gallons of gasoline were consumed in the Bay Area during 2002 (excluding aviation fuel), which translates to about 9.4 million gallons each day. Over the three-year period, gasoline consumption in the Bay Area increased by one percent, with minor decreases in consumption in San Francisco and San Mateo counties. The remaining seven counties all increased one percent.

Caltrans estimates that over the next two decades, the Bay Area can expect a 36 percent increase in gasoline consumption and a 41 percent increase in the number of vehicle miles traveled. The California Energy Commission reported that 435.9 gallons of gasoline were used per capita in 2002, compared to a national average of 461.1 gallons per person (Caltrans, 2004).

Natural Gas

Four regions supply California with natural gas. Three of them—the Southwestern U.S., the Rocky Mountains, and Canada—supply 84 percent of all the natural gas consumed in California (CEC, 2000). The remainder of the natural gas is produced in California. In 2000, approximately one-third of all the natural gas consumed in California was used to generate electricity. Residential consumption represented one-fifth of California natural gas use with the balance consumed by the industrial, resource extraction, and commercial sectors.

PG&E is the primary natural gas provider for the San Francisco Bay Area. PG&E obtains its energy supplies from natural gas fields in northern California.

Table 2.4-1: Gasoline Consumption in the San Francisco Bay Area 2000 to 2002, in 1,000 Gallons (excludes fuel for aviation use and diesel)

County	*2000*	*2001*	*2002*	*Change 2000-2002*
Alameda	665,743	670,748	688,174	1.0%
Contra Costa	429,507	429,131	446,724	1.0%
Marin	132,634	131,394	133,873	1.0%
Napa	59,806	60,211	62,945	1.0%
San Francisco	392,878	405,009	391,153	-0.1%
San Mateo	406,305	406,291	403,870	-0.1%
Santa Clara	891,038	913,369	897,267	1.0%
Solano	169,114	170,896	181,609	1.1%
Sonoma	211,209	211,971	221,054	1.0%
Bay Area	3,358,234	2,399,020	3,426,669	1.0%

Source: California Department of Transportation, Office of Transportation Economics, Division of Transportation Planning, April 2004; Environmental Science Associates, 2004

Electricity

Power plants in California meet approximately 77 percent of the in-state electricity demand; hydroelectric power from the Pacific Northwest provides another 10 percent and power plants in the southwestern U.S. provide another 13 percent (CEC, 2003a). The contribution between in-state and out-of-state power plants depends upon, among other factors, the precipitation that occurred in the previous year and the corresponding amount of hydroelectric power that is available. In the Bay Area, Contra Costa County is home to one of the largest power plants in California: the Pittsburg Power Plant. It is the fourth largest power plant in California and consumes natural gas. Smaller power plants and cogeneration facilities are located throughout the Bay Area. PG&E is the primary electricity supplier to northern California.

Alternative Fuels

The U.S. Department of Transportation currently recognizes the following as alternative fuels: methanol and denatured ethanol (alcohol mixtures that contain no less than 70 percent of the alcohol fuel), natural gas (compressed or liquefied), liquefied petroleum gas, hydrogen, coal-derived liquid fuels, fuels derived from biological materials (i.e., biomass), and electricity. The liquid fuel referred to as Methanol (M85) consists of methanol and gasoline and is derived from natural gas, coal, or woody biomass. The liquid fuel referred to as Ethanol (E85) consists of ethanol and gasoline and is derived from corn, grains or agricultural waste. Natural gas consists of a high percentage of methane (generally above 85 percent), and varying amounts of ethane, propane, butane, and inerts (typically nitrogen, carbon dioxide, and helium) and comes from underground reserves. Liquefied petroleum gas (LPG) consists mostly of propane and is a byproduct of petroleum refining or natural gas processing. Current technologies for electric vehicles include lead acid and nickel metal hydride batteries.

Energy Use for Transportation

Transportation is the largest energy consumer in the state, accounting for 60 percent of total energy use (CEC, 1999). On-road vehicles are estimated to consume approximately 80 percent of California's transportation energy demand, with cars, trucks, and buses accounting for nearly all of the on-road fuel consumption.

On-road vehicles use about 90 percent of the distillate (petroleum) consumed in California. Caltrans estimates that in 2005 over 3.3 billion gallons of gasoline and diesel fuel will be consumed in the nine Bay Area counties, an increase of about 127 million gallons over 2000 consumption levels (Caltrans, 2003).

Long-term energy consumption trends for transportation will be largely determined by fuel efficiency trends for motor vehicles, as motor vehicles are the predominant transportation mode for passengers and commercial goods.

Energy Used By Public Transit

Public Transit energy consumption includes energy consumed for operation of public buses, electrified rail systems, and ferries. Energy factors for buses, BART, commuter rail, and ferries are provided in Table 2.4-2. The energy efficiency of each of these modes may vary according to operating conditions.

Table 2.4-2: Energy Factors of Transit Service

Service	*Energy Factor (BTU/Vehicle Mile)*
Commuter Rail - Diesel	466,667
Commuter Rail – Electric	102,000
Rail Rapid Transit	77,739
Diesel Multiple Unit	75,000
Bus	36,900
Ferry	32,634
Diesel Bus	19,858

Source: American Public Transit Association, 2003; Oak Ridge National Laboratory, 1996; The sources for Diesel Multiple Units is Colorado Railcar Company, LLC, 2003.

Energy used by Private and Commercial Vehicles

Commercial vehicles, generally composed of light, medium, and heavy trucks, are typically fueled by diesel or gasoline, and are part of the general fleet mix of vehicles present within the Bay Area transportation system. This energy analysis uses an average on-road vehicle fleet fuel economy of 18.26 miles per gallon in 2000, based on the 2003 California Motor Vehicle Stock, Travel and Fuel Forecast 2003 (Caltrans, 2003).

In the short-term, average fuel economy is expected to decrease due to the increase in light duty trucks as a fraction of the light duty vehicle fleet in California. Model year 2000 cars had the lowest recorded fuel economy ratings since 1980, largely due to buyer preferences for sport utility vehicles (21 percent of new car sales in the U.S.). Since 1981, improved engine performance has largely been offset by an increase in the average weight of cars and light duty trucks (10 percent and 16 percent, respectively).

The California Energy Commission projects that "fuel efficiency (by class) for gasoline light duty vehicles will decline slightly under model year 2007 or 2008, reflecting recent trends, and then begin to increase." Light duty vehicles include automobiles, pickup trucks, vans, and sport utility vehicles (SUVs). The anticipated increase is due to the expected addition of hybrid-electric vehicles and the zero emission vehicle mandate, as well as the replacement of older and lower fuel efficiency vehicles over time (California Energy Commission, 2003).

Global Warming

Scientists and climatologists have cited evidence that the burning of fossil fuels by vehicles, power plants, industrial facilities, residences and commercial facilities have led to an increase of the earth's temperature. While climate changes can result from many natural processes, it is argued that human activities may be accelerating the warming process. The concentration of greenhouse gases in the atmosphere changes the amount of heat that is radiated from the earth back into space. Greenhouse gases include carbon dioxide, methane, ozone, halocarbons and nitrous oxide.

Carbon dioxide is one of the most potent greenhouse gases, as it traps more heat in the atmosphere than other greenhouse gases, and, much of it tends to remain in the atmosphere for centuries (Scientific America, 1998). The United States has the highest per capita emissions of greenhouse gases of any country in the world. Transportation accounts for about 40 percent of the carbon dioxide (the primary pollutant responsible for global warming) produced in California (CEC, 1999). That figure far outpaces the national average of 33 percent (BTS, 2002).

REGULATORY SETTING

Federal and state agencies regulate energy consumption through various policies, standards, and programs. At the local level, individual cities and counties regulate energy through their regulatory and planning activities.

Federal Regulations

The 1975 Warren-Alquist Act established the California Energy Resources Conservation and Development Commission, now known as the California Energy Commission. The Act established a State policy to reduce wasteful, uneconomical and unnecessary uses of energy by employing a range of measures. The California Public Utilities Commission regulates privately-owned utilities in the energy, rail, telecommunications, and water fields.

A CEQA amendment requires projects subject to EIRs to include a discussion of the potential energy impacts of proposed projects in the EIR, with particular emphasis on avoiding or reducing inefficient, wasteful and unnecessary consumption of energy (CELSOC, 2002).

The Energy Policy and Conservation Act (EPCA) of 1975 established nationwide fuel economy standards in order to conserve oil. Pursuant to this Act, the National Highway Traffic and Safety Administration, part of the U.S. Department of Transportation, is responsible for revising existing fuel economy standards and establishing new vehicle fuel economy standards.

The Corporate Average Fuel Economy (CAFE) program was established to determine vehicle manufacturer compliance with the government's fuel economy standards. Compliance with CAFE standards is determined based on each manufacturer's average fuel economy for the portion of their vehicles produced for sale in the United States. The U.S. EPA calculates a CAFE value for each manufacturer based on city and highway fuel economy test results and vehicle sales. The CAFE values are a weighted harmonic average of the EPA city and highway fuel economy test results. Based on information generated under the CAFE program, the U.S. Department of Transportation is authorized to assess penalties for noncompliance.

CAFE rules require the average fuel economy of all vehicles of a given class that a manufacturer sells in each model year to be equal of greater than the standard. The current CAFE standard for passenger cars is 27.5 miles per gallon and 20.7 miles per gallon for light trucks (gross vehicle weight of 8,500 pounds or less). Heavy-duty vehicles (i.e. gross vehicle weight over 8,500 pounds) are not currently subject to fuel economy standards. The EPCA was reauthorized in 2000 (49 CFR 533).

State Regulations

State of California Energy Plan

The CEC is responsible for preparing the State Energy Plan, which identifies emerging trends related to energy supply, demand, conservation, public health and safety, and the maintenance of a healthy economy. The current plan is the 1997 California Energy Plan (CEC, 1997). The plan calls for the state to assist in the transformation of the transportation system to improve air quality, reduce congestion, and increase the efficient use of fuel supplies with the least environmental and energy costs. To further this policy, the plan identifies a number of strategies, including assistance to public agencies and fleet operators in implementing incentive programs for zero-emission vehicles and addressing their infrastructure needs; and encouragement of urban designs that reduce vehicle miles traveled and accommodate pedestrian and bicycle access.

California Environmental Quality Act (CEQA)

Appendix F of the CEQA Guidelines describes the types of information and analyses related to energy conservation that are to be included in Environmental Impact Reports (EIRs). In Appendix F of the CEQA Guidelines, energy conservation is described in terms of decreased per capita energy consumption, decreased reliance on natural gas and oil, and increased reliance on renewable energy sources. To assure that energy implications are considered in project decisions, EIRs must include a discussion of the potentially significant energy impacts of proposed projects, with particular emphasis on avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy.

IMPACT ANALYSIS

SIGNIFICANCE CRITERIA

This EIR uses the following criterion to assess impacts on energy consumption:

- **Criterion 1: Five percent or greater increase in energy consumption.** Implementation of transportation improvements in the proposed Transportation 2030 Plan would have a potentially significant impact if it results in a 5 percent or greater increase in energy consumption compared to the No Project alternative.

METHOD OF ANALYSIS

Energy consumption includes energy required for operation of the transportation system (private vehicles and public transit) as well as energy used for construction and maintenance of the transportation system. The analysis assumes that the proposed Transportation 2030 Plan is implemented in full in the year 2030. The analysis assesses cumulative impacts; it assumes the implementation of the proposed Transportation 2030 Plan as well as the development of all forecast land use changes. As a result, the EIR evaluates both the changes in vehicle miles traveled (VMT) that the proposed Transportation 2030 Plan would lead to as well as the additional travel in the regional transportation system generated by planned land uses. This analysis is based on output from MTC's travel demand model.

Direct Energy Consumption

Direct energy is that energy used in the daily operation of the transportation system, including the propulsion of on-road vehicles and transit vehicles under varying conditions. In assessing the direct energy impact, consideration was given to the following factors: fleet mix; annual VMT; and variation of fuel consumption rates over time and by vehicle type.

The direct energy analysis for the Proposed Project is based on project year 2030 VMT compared to estimates for both existing conditions (2000) and the No Project alternative. This analysis compares the estimated gasoline/diesel consumption of vehicles on the regional roadway network (i.e., the portion of the network included in the travel demand model) that would result under implementation of the proposed Transportation 2030 Plan to estimates for the 2000 base year. This difference would be the relative impact of the proposed Transportation 2030 Plan on vehicular energy used in the region. Modal output data used in the direct energy calculations and the results for auto energy use are shown in Table 2.4-3.

Table 2.4-3: Direct Energy Data

	VMT	*Speed (mph)*	*Adjusted Fuel Economy (mph)*	*Btu/Mile*	*Auto Energy Use (Btus)*
2000	13,128,555	38.10	34.42	4076.4	53.4
2030 No Project	17,868,053	34.62	32.42	4318.3	77.16
2030 Project	17,772,807	37.24	34.86	4016.1	71.38

Source: Metropolitan Transportation Commission 2004, Environmental Science Associates, 2004

Effect of Speed on Fuel Efficiency

It is known that vehicle travel at speeds different from the most fuel-efficient speed can lead to dramatic increases in fuel consumption. While a precise relation for the entire fleet of vehicles is not known, the effect of a reduction of average speed in the region can be estimated. The estimated average speed on regional Bay Area roadways in 2030 without the project is 34.62 miles per hour. The average fleet fuel economy is estimated to be 34.42 miles per gallon.

Estimates of the difference in energy consumption at different average speeds in the future scenarios are based on data in the Transportation *Energy Data Book*: Edition 23 (Oak Ridge National Laboratory, 2003). According to this data, vehicle speeds from approximately 30 miles per hour to approximately 35 miles per hour would result be operating to their full fuel economy potential. The forecast average speed under the Proposed Project is 37.24 miles per hour on regional roadways. The estimated fuel economy associated with this speed is 34.86 miles per gallon. This analysis does not assume increases in fleet fuel economy due to changes in technology, as the effects on the average fuel economy of the 2030 vehicle fleet remains uncertain. This analysis also does not account for possible changes between alternatives in vehicle trips or mode due to changes in average speed. Future environmental analysis associated with projects in the proposed Transportation 2030 Plan could take speed changes, stops and slow-downs, terrain and other factors into account when determining energy consumption for different alternatives.

Indirect Energy Consumption

Indirect energy is the energy required to construct, operate, and maintain the transportation network, as well as to manufacture and maintain on-road vehicles and transit vehicles. Indirect energy consumption also includes changes in energy demand due to a project, such as changes in trip origins and destinations or travel modes. Indirect energy consumption due to production of fuel and transportation/transmission to the end users is not included in this analysis, as any such analysis would be speculative.[2]

Because many of the projects included in the proposed Transportation 2030 Plan are at conceptual planning stages, no detailed quantitative assessment of construction and maintenance impacts is possible. Instead, a rough estimate of the energy that would be consumed for

[2] The Annual Report on Transportation Statistics, published by the Bureau of Transportation Statistics of the U.S. Department of Transportation only includes end user energy consumption by transportation mode, with no information available on manufacturing transportation fuels or different types of transportation equipment.

construction and maintenance proposed under the Transportation 2030 Plan can be made by applying the Input-Output methodology developed by Caltrans (1983). The Input-Output method converts VMT, lanes-miles or construction dollars into energy consumption based on existing data of other transportation projects in the U.S. Table 2.4-4 shows the indirect energy consumption factors used in this analysis.

Table 2.4-4: Indirect Energy Consumption Factors

Mode	*Factor*
Construction	
Automobiles and Trucks (manufacturing)	1,410 BTUs/vehicle Miles
Bus (manufacturing)	3,470 BTUs/Vehicle Miles
Roadway (construction)	27,300 BTUs/1977$
Rail (construction)	2,108 BTUs/Mile
Tunnel (construction)	46,228 BTUs/Mile
Maintenance	
Automobiles and Trucks	1,400 BTUs/Vehicle Mile
Bus	13,142 BTUs/Vehicle Mile
Roadway	1.71x108 BTUs/Vehicle Mile/Year
Rail	7,060 BTUs/Vehicle Mile

[1]BTU: British Thermal Units

[2]2004 dollars converted to 1977 dollars and 1982 dollars

[3]Estimated to be ten times the energy impact of road construction.

Source: Caltrans, 1983

SUMMARY OF IMPACTS

Direct and Indirect Energy

Both the Proposed Project and No Project alternative would result in higher daily energy consumption relative to existing conditions (2000). The Proposed Project's daily energy consumption for direct energy would be roughly 39.6 percent higher than existing energy use. The Proposed Project's energy use would be 13.7 percent higher than the estimated 2030 No Project direct energy consumption. This increase is attributed to higher transit use in the Proposed Project, which requires more energy for some modes of travel (e.g., ferries and commuter rail).

There would be indirect energy impacts from the consumption of energy for construction, manufacturing, and maintenance purposes under the Proposed Project. The indirect average daily energy consumption would be 69 percent more than existing conditions. Existing conditions uses less indirect energy then the Proposed Project because of the lack of large scale construction projects. The Proposed Project indirect energy consumption would be 31.4 percent higher than the No Project alternative indirect energy consumption. The increase can be attributed to the construction of large transportation projects under the Proposed Project.

With respect to total transportation-related energy use, the Project is estimated to use 169.02 Btus on a daily basis- a 18.2 percent increase over the No Project estimates of 143.04. Under existing conditions transportation energy use is estimated at 115.13 Btus on a daily bases- 46.8 percent less than the Project.

Global Warming and CO2 Emissions

The greenhouse gas carbon dioxide, which contributes to global warming, is largely produced by transportation related sources. As shown in Table 2.4-5, under existing conditions carbon dioxide emissions are calculated to be 542.73 tons per day. The Proposed Project is expected to increase the output by over 22 percent to 698.68 tons per day. However, the No Project alternative is projected to generate 3 percent more carbon dioxide emissions than the Proposed Project, so the impact of the Proposed Project is not considered significant. It would improve conditions relative to the No Project alternative.

Table 2.4-5: Carbon Dioxide Emissions

Scenario	*Estimated Output*	*Change from 2000*		*Change from 2030 No Project*	
		Numerical	*Percent*	*Numerical*	*Percent*
2000	542.73	-	-	-178.78	-25%
2030 No Project	721.51	178.78	25%	-	-
2030 Project	698.68	155.95	22%	-22.83	-3%

Source: MTC Model Outputs 2004

IMPACTS & MITIGATION

Impact

2.4-1 The implementation of the Proposed Project is likely to substantially increase the consumption of direct and indirect energy types. ***(Significant unavoidable)***

Under existing conditions, daily direct transportation energy usage is 87.20 billion Btus. As shown in Table 2.4-6, daily energy consumption for direct energy usage under the Proposed Project would be approximately 121.72 billion Btus. This is an 13.7 percent increase from the estimated 2030 No Project direct energy consumption, and roughly 39.6 percent more energy then existing conditions.

The average speed in the regional network would be slightly lower than in 2000 but higher than the No Project alternative condition. This change in average speed would result in a minor change in average fuel economy and a decrease in transportation energy consumption compared to the No Project alternative.

As shown in Table 2.4-6, energy consumption for construction, manufacturing, and maintenance purposes under the Proposed Project would be approximately 47.30 billion Btus on an average daily basis through 2030. This is a 69 percent increase over existing conditions and a 31.4 percent increase over the estimated No Project alternative indirect energy consumption.

The Proposed Project would result in a 18.2 percent increase in overall transportation energy consumption compared to the No Project alternative; this is a significant adverse impact. The Proposed Project total energy consumption per capita would be 13.4 percent higher than existing conditions.

Mitigation Measures

Mitigation of these impacts is largely beyond the authority of MTC. The most significant mitigation measure would be adoption and implementation of more rigorous Corporate Average Fuel Economy standards for passenger cars and light trucks. In light of this, the following mitigation measures are recommended.

Table 2.4-6: Estimated Daily Direct and Indirect Energy Consumption (in Billion Btus)

				Change 2000 to 2030 Project		*Change 2030 No Project to 2030 Project*	
	2000	*2030 No Project*	*2030 Project*	*Numerical*	*Percent*	*Numerical*	*Percent*
Direct Energy							
On-Road vehicles	53.40	77.16	71.38	17.98	33.7%	-5.78	-0.1%
Transit vehicles	33.81	29.88	50.34	16.53	40.9%	20.46	59.4%
Direct Energy Total	87.20	107.04	121.72	34.52	39.6%	14.68	13.7%
Indirect Energy							
Manufacturing and Maintenance	27.93	34.90	35.18	7.25	26.0%	0.28	0.1%
Construction	-	1.10	12.12	12.12	100%	11.02	1,100%
Indirect Energy Total	27.93	36.00	47.30	19.37	69.4%	11.30	31.4%
Total Daily Energy	115.13	143.04	169.02	53.89	46.8%	25.98	18.2%
Per Capita Daily Energy Usage (Btus)	16,972	16,291	19,250	2,278	13.4%	2,959	18.2%

Btu: British Thermal Units

Source: Environmental Science Associates 2004, Metropolitan Transportation Commission, 2004

2.4(a) Project implementation agencies shall undertake project specific review of energy impacts as part of project specific environmental review. For any identified impacts, appropriate mitigation measures shall be identified. The project implementation agencies or local jurisdictions shall be responsible for ensuring adherence to the mitigation measures. MTC shall be provided with documentation of compliance with mitigation measures.

2.4(b) Project implementation agencies shall require projects, that are part of the proposed Transportation 2030 Plan, that require construction, to evaluate the energy demand so that suggestions could be made requiring the least energy-intensive methods of construction. To reduce energy expended, the construction contractor could implement the following mitigation measures:

- Minimize the number of transportation trips that take materials to and from construction sites;
- Do not needlessly run construction equipment engines;
- Require that all construction engines be properly tuned;
- Encourage ridesharing by construction personnel traveling to and from construction sites; and
- Plan construction actives to minimize the use of all on-site construction equipment.

These mitigation measures are not expected to reduce this potentially significant adverse impact to a less-than-significant level.

2.5 Noise

In most of the Bay Area, transportation—motor vehicles, transit systems, railroads, aircraft and boats—is the primary source of environmental noise. Automobile and truck traffic is the most prevalent noise source throughout the region's urban communities. Noise can have real effects on human health, including hearing loss and the psychological effects or irritability from lack of sleep. This chapter outlines how noise is described, measured, and regulated. It also describes the sources of transportation noise in the Bay Area and evaluates the potential effect of transportation improvements in the proposed Transportation 2030 Plan on noise levels within the region.

ENVIRONMENTAL SETTING

PHYSICAL SETTING

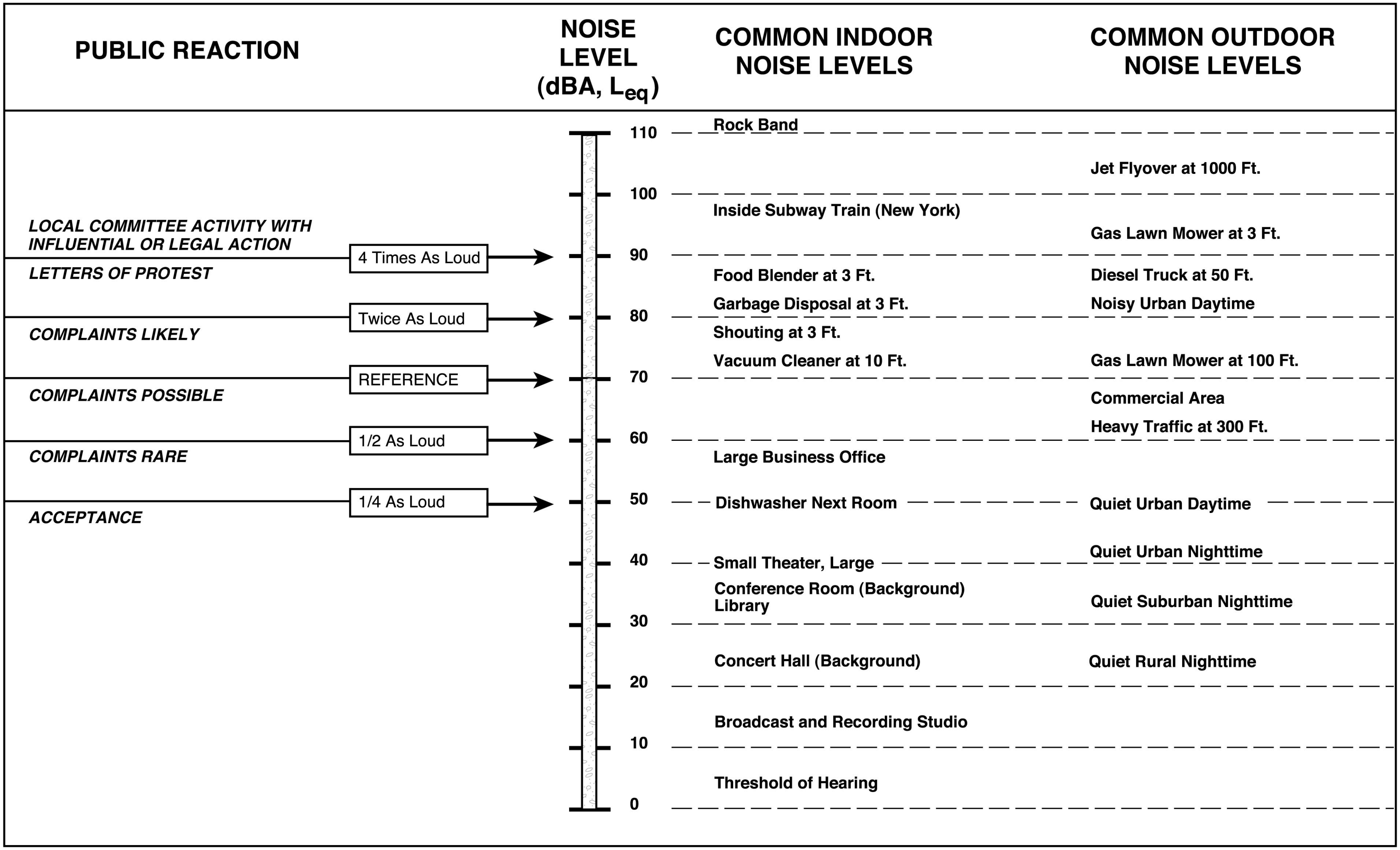
Noise Descriptors

Sound waves, traveling outward from a source, exert a sound pressure level (commonly called "sound level"), measured in decibels (dB). In general, people can perceive a two- to three-dB difference in noise levels; a five-dB difference in noise levels is readily perceptible; a difference of 10 dB is perceived as a doubling of loudness. "Noise" is often defined as unwanted sound. Environmental noise is usually measured in A-weighted decibels, which is a metric corrected for the variation in frequency response of the human ear. The A-weighted scale is used to describe all noise levels discussed in this section.

Environmental noise levels typically fluctuate over time; different types of noise descriptors are used to account for this variability. Some descriptors characterize cumulative noise over a given period, while others describe single noise events. Cumulative noise descriptors include the energy-equivalent noise level (L_{eq}), Day-Night Average Noise Level (DNL), and Community Noise Equivalent Level (CNEL). The L_{eq} is the actual time-averaged, equivalent steady-state sound level, which, in a stated period, contains the same acoustic energy as the time-varying sound level during the same period. Some representative noise sources and their corresponding A-weighted noise levels are shown in Figure 2.5-1.

DNL and CNEL values result from the averaging of L_{eq} values (based on A-weighted decibels) over a 24-hour period, with weighting factors applied to different periods of the day to account for their greater relative annoyance. For DNL, noise that occurs during the nighttime period (10:00 p.m. to 7:00 a.m.) is penalized by 10 dBA. The CNEL descriptor is similar to DNL, except that it also includes a penalty of approximately 5 dBA for noise that occurs during the evening period (7:00 p.m. to 10:00 p.m.). Cumulative noise descriptors, DNL and CNEL, are well correlated with the likelihood of public annoyance from transportation noise sources.

Individual noise events, such as train passbys, are further described using single-event and cumulative noise descriptors. For single events, the maximum measured noise level (L_{max}) is often cited, as is the Sound Exposure Level (SEL). The SEL is the energy-based sum of a given-duration noise event squeezed into a reference duration of one second.



Source: Caltrans Transportation Laboratory Noise Manual, 1982; and Modification by Environmental Science Associates, 2001.

Figure 2.5-1
Noise Effects on People

Sound Propagation and Attenuation

Sound level naturally decreases as one moves further away from the source. This basic attenuation rate is referred to as the *geometric spreading loss*. The basic rate of geometric spreading loss depends on whether a given noise source can be characterized as a point source or a line source.

For a point source, such as an idling truck or jackhammer, the noise level decreases by about 6.0 dBA for each doubling of distance away from the source. In many cases, noise attenuation from a point source increases by 1.5 dBA from 6.0 dBA to 7.5 dBA for each doubling of distance due to ground absorption and reflective wave canceling. These factors are collectively referred to as *excess ground attenuation*. The basic geometric spreading loss rate is used where the ground surface between a noise source and a receiver is reflective, such as parking lots or a smooth body of water. The excess ground attenuation rate (7.5 dBA per doubling of distance) is used where the ground surface is absorptive, such as soft dirt, grass, or scattered bushes and trees.

For a line source, such as a heavily traveled roadway, the noise level decreases by a nominal value of 3.0 dBA for each doubling of distance between the source and the receiver. If the ground surface between source and receiver is absorptive rather than reflective, the nominal rate increases by 1.5 dBA to 4.5 dBA for each doubling of distance. Atmospheric effects, such as wind and temperature gradients, can also influence noise attenuation rates from both line and point sources of noise. However, unlike ground attenuation, atmospheric effects are constantly changing and difficult to predict.

Trees and vegetation, buildings, and barriers reduce the noise level that would otherwise occur at a given receptor distance. However, for a vegetative strip to have a noticeable effect on noise levels, it must be dense and wide. For example, a stand of trees must be at least 100 feet wide and dense enough to completely obstruct a visual path to the roadway to attenuate traffic noise by 5 dBA.[1] A row of structures can shield more distant receivers depending upon the size and spacing of the intervening structures and site geometry. Generally, for an at-grade highway in an average residential area where the first row of houses cover at least 40 percent of the total area, the reduction provided by the first row of houses is approximately 3 dBA, and 1.5 dBA for each additional row.[2] Similar to vegetative strips discussed above, noise barriers, which include natural topography and soundwalls, reduce noise by blocking the line of sight between the source and receiver. Generally, a noise barrier that breaks the line of sight between source and receiver will provide at least a 5-dBA reduction in noise.

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[1] California Department of Transportation (Caltrans), *Technical Noise Supplement, A Technical Supplement to the Traffic Noise Analysis Protocol*, October 1998.
[2] Ibid.

Effects of Noise

Human reaction to noise ranges from annoyance, to interference with various activities, to hearing loss and stress-related health problems. These effects of noise are discussed below:

- ***Potential hearing loss*** is commonly associated with occupational exposures in heavy industry or very noisy work environments. Noise levels in neighborhoods, even near very noisy airports, are not sufficiently loud to cause hearing loss.
- ***Speech interference*** is one of the primary concerns associated with environmental noise. Normal conversational speech is in the range of 60 to 65 dBA and any noise in this range or louder may interfere with speech. Depending upon the distance between the talker and the listener, background noise levels may require a raised voice in order to communicate. Transportation sources can easily interfere with conversation within a few hundred feet of the source.
- ***Sleep interference*** is a major noise concern related to traffic-generated noise. Sleep disturbance studies have identified interior noise levels attributed to traffic noise as a key factor of sleep disturbance. However, it should be noted that sleep disturbance does not necessarily mean awakening from sleep, but can refer to altering the pattern and stages of sleep. Train noise (especially horn soundings) is a major source of complaints.
- ***Physiological responses*** are those measurable noise effects on the human metabolism. They are ascertained as changes in pulse rate, blood pressure, etc. While such effects can be induced and observed, the extent to which these physiological responses cause harm or are a sign of harm is not known.
- ***Annoyance*** is the most difficult of all noise responses to describe. Annoyance is a very individual characteristic and can vary widely from person to person. What one person considers tolerable can be quite unbearable to another of equal hearing capability. (For instance, some people like the sound of trains, while others do not.)

Sensitive Receptors

People in residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, auditoriums, natural areas, parks and outdoor recreation areas are generally more sensitive to noise than are people at commercial and industrial establishments. Consequently, the noise standards for sensitive land uses are more stringent than for those at less sensitive uses. Sensitive receptors of all types are located within the Transportation 2030 Plan travel corridors.

To protect various human activities in sensitive areas (e.g., residences, schools, and hospitals), lower noise levels are generally required. For example, a maximum outdoor noise level of 55 to 60 DNL is necessary for intelligible speech communication inside a typical home. Social surveys and case studies have shown that complaints and community annoyance in residential areas begin to occur when outdoor noise reaches 55 DNL.[3] Sporadic complaints associated with the 55 to 60 DNL range give rise to widespread complaints and sometimes individual threats of legal action

[3] U.S. Environmental Protection Agency, *Noise Effects Handbook*, July 1981.

within the 60 to 70 DNL range. At 70 DNL and above, residential community reaction typically involves threats of legal action and strong appeals to local officials to stop the noise.

Existing Noise Sources

Principal Bay Area noise sources are airports, freeways, arterial roadways, port facilities, and railroads. Additional noise generators include industrial manufacturing plants and construction sites. Local collector streets are not considered to be a significant source of noise since traffic volume and speed are generally much lower than for freeways and arterial roadways.

Airports

The Bay Area airport system consists of a total of 47 airport facilities, including 4 commercial service airports, 22 general aviation airports, 3 military airports, 2 special use airports and 16 private use airports. Airport operation, particularly the large commercial service airports play a significant role in the noise environment of many Bay Area communities. Bay Area airport system development is addressed regionally in the *Regional Airport System Plan* (RASP) and locally in individual airport master plans. The airport master plans address community noise issues near airports.

Freeways and Arterial Roadways

Vehicle traffic background noise levels vary throughout the day based on the average density of noise sources in a given area. Traffic noise at a particular location depends upon the traffic volume on the roadway, the average vehicle speed, distance between the receptor and the roadway, the presence of intervening barriers between source and receiver, and the ratio of trucks (particularly heavy trucks) and buses to automobiles.

A number of factors control how traffic noise levels affect nearby sensitive land uses. These factors include: roadway elevation compared to grade; structures or terrain intervening between the roadway and the sensitive receptors; and the distance between the roadway and receptors. For example, measurements show that depressing a freeway by approximately 12 feet yields a reduction in traffic noise relative to an at-grade freeway of 7 to 10 dBA at all distances from the freeway.[4] Traffic noise from an elevated freeway is typically 2 to 10 dBA lower than an equivalent at-grade facility within 300 feet of the freeway. However, beyond 300 feet, the noise radiated by an elevated and at-grade freeway (assuming equal traffic volumes, truck mix, and vehicle speed) is the same.[5] Caltrans or other sponsors of freeway projects conduct detailed noise studies for their environmental documents when these projects are ready for implementation.

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[4] Beranek, Leo L., *Noise and Vibration Control*, 1988.
[5] Ibid.

The Bay Area has an enormous number of arterial roadways. Typical arterial roadways have one or two lanes of traffic in each direction, with some containing as many as four lanes in each direction. Noise from these sources can be a significant environmental concern where buffers (e.g., buildings, landscaping, etc.) are inadequate or where the distance from centerline to sensitive uses is relatively small. Given typical daily traffic volumes of 10,000 to 40,000, noise levels along arterial roadways typically range from DNL 65 to 70 dBA at a distance of 50 feet from the roadway centerlines. In some cases, traffic noise is so pervasive that it can depress property values for residential uses. Project sponsors for new or widened arterials conduct detailed noise analyses for these projects as part of their environmental documents when these projects are ready for implementation.

Railroad Operations

The two basic types of railroad operations are freight trains and passenger rail operations, the latter consisting of commuter and intercity passenger trains and steel-wheel urban rail transit. Generally, freight operations occur at all hours of the day and night, while passenger rail operations are concentrated within the daytime and evening periods.

Trains can generate high, relatively brief, intermittent noise events. Train noise is an environmental concern for sensitive uses located along rail lines and in the vicinities of switching yards. Locomotive engines and the interaction of steel wheels and rails generate primary rail noise. The latter source creates three types of noise: 1) rolling noise due to continuous rolling contact; 2) impact noise when a wheel encounters a rail joint, turnout or crossover; and 3) squeal generated by friction on tight curves. For very high-speed rail vehicles, air turbulence can be a significant source of noise.[6]

Train air horns and crossing bell gates contribute to loud noise levels near grade crossings. Table 2.5-1 provides reference noise levels in terms of Sound Exposure Levels (SEL) for different types of rail operations.

Freight Trains

Freight trains are a source of environmental noise at many locations in the Bay Area. Freight train noise consists of locomotive engine sound and rail car wheel-rail interaction. In addition to noise, freight trains also generate substantial ground-borne noise and vibration near the tracks. Ground-borne noise and vibration is a function of quality of the track and the operating speed of the vehicles. (Improvements to private railroad rights of way are not part of the proposed Transportation 2030 Plan).

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[6] U.S. Department of Transportation, Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, April 1995.

Table 2.5-1: Reference Noise Levels for Various Rail Operations

Source/Type		*Reference Conditions*	*Reference Noise Level (SEL)*[1]
Commuter Rail, At-Grade	Locomotives	Diesel-Electric, 3,000 horsepower, throttle 5	92
		Electric	90
	Cars	Ballast, welded rail	82
Rail Transit		At-grade, ballast, welded rail	82
Automated Guideway Transit	Steel wheel	Aerial, concrete, welded rail	80
	Rubber tire	Aerial, concrete guideway	78
Monorail		Aerial straddle beam	82
Maglev		Aerial, open guideway	72

[1] Measured at 50 feet from track centerline with trains operating at 50 miles per hour. For the sake of comparison, an automobile passby event generates an SEL of approximately 73 dBA, and a city bus generates an SEL of approximately 84 dBA.

Source: U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment, April 1995

Commuter and Intercity Passenger Trains

In the Bay Area, there are four commuter and intercity passenger train operators: Caltrain, Capitol Corridor, ACE, and AMTRAK. Passenger trains can be powered by diesel or electric locomotives, with the electric motors being comparatively quiet. Noise from local and regional passenger trains is primarily from diesel engines and train whistles.

Heavy and Light Rail Transit

Heavy rail is generally defined as electrified rapid transit trains with dedicated guideway, and light rail as electrified transit trains that do not require dedicated guideway. In general, noise increases with speed and train length, and is most problematic within 50 feet of the track. BART trains, operating at- or above-grade, typically generate noise levels of about 70 DNL at a distance of 100 feet from the tracks. The DNL drops to about 60 dBA at a distance of 400 feet.

Light rail noise levels vary, depending upon vehicle speed, number of cars per train, and whether the trains operate on embedded or tie-and-ballast trackway. The distance to the 60 DNL contour for light rail is typically 100 to 150 feet from the tracks.

Construction Noise Sources

Construction can be another significant, although typically short-term, source of noise. Construction is most significant when it takes place near sensitive land uses and occurs at night or in early morning hours. As discussed above, local governments typically regulate noise associated with construction equipment and activities through enforcement of noise ordinance standards, implementation of general plan policies, and imposition of conditions of approval for building or grading permits. Table 2.5-2 shows typical exterior noise levels at various phases of commercial construction, and Table 2.5-3 shows typical noise levels associated with various types of construction related machinery.

Table 2.5-2: Typical Construction Phase Noise Levels

Construction Phase	*Noise Level (dBA, L_{eq})*[1]
Ground Clearing	84
Excavation	89
Foundations	78
Erection	85
Finishing	89

[1] Average noise levels 50 feet from the noisiest source and 200 feet from the rest of the equipment associated with a given construction phase. Noise levels correspond to commercial projects in a typical urban ambient noise environment.

Source: Bolt, Beranek and Newman, U.S. EPA, Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances, 1971

The dominant construction equipment noise source is usually a diesel engine, without sufficient muffling. In a few cases however, such as impact pile driving or pavement breaking, process noise dominates. Stationary equipment operates in one location for one or more days at a time, with either a fixed-power operation (pumps, generators, compressors) or a variable noise operation (pile drivers, pavement breakers). Mobile equipment moves around the construction site with power applied in cyclic fashion (bulldozers, loaders), or to and from the site (trucks). Construction-related noise levels generally fluctuate depending on the construction phase, equipment type and duration of use, distance between noise source and receptor, and presence or absence of barriers between noise source and receptor.

REGULATORY SETTING

Federal, state and local agencies regulate different aspects of environmental noise. Generally, the federal government sets noise standards for transportation-related noise sources closely linked to interstate commerce. These include aircraft, locomotives, and trucks. The state government sets noise standards for those transportation noise sources such as automobiles, light trucks, and motorcycles. Noise sources associated with industrial, commercial, and construction activities are generally subject to local control through noise ordinances and general plan policies. Local general plans identify general principles intended to guide and influence development plans, and noise ordinances set forth the specific standards and procedures for addressing particular noise sources and activities.

Federal Regulations

Federal regulations for railroad noise are contained in 40 CFR, Part 201 and 49 CFR, Part 210. Noise limits are implemented through regulatory controls on locomotive manufacturers. For locomotives manufactured during or after 1980, noise limits are as follows:

- Stationary locomotives (at idle throttle setting) are not to exceed 70 dBA at 15 meters (approximately 50 feet) from the track pathway centerline;
- Stationary locomotives (at all other throttle settings) are not to exceed 87 dBA at 15 meters; and
- Moving locomotives are not to exceed 90 dBA at 15 meters.

Table 2.5-3: Typical Noise Levels from Construction Equipment

	Noise Levels (dBA at 50 feet)	
Construction Equipment	*Without Noise Control*	*With Feasible Noise Control*[1]
Earthmoving		
Front Loaders	79	75
Backhoes	85	75
Dozers	80	75
Tractors	80	75
Scrapers	88	80
Graders	85	75
Trucks	91	75
Pavers	89	80
Materials Handling		
Concrete Mixers	85	75
Concrete Pumps	82	75
Cranes	83	75
Derricks	88	75
Stationary		
Pumps	76	75
Generators	78	75
Compressors	81	75
Impact		
Pile Driver	101	95
Jack Hammers	88	75
Rock Drills	98	80
Pneumatic Tools	86	80
Other:		
Saws	78	75
Vibrators	76	75

1 Feasible noise controls represent estimates obtained by using quieter procedures or equipment and noise control features that would require no major design or extreme cost. Quieted equipment can be designed with enclosures, mufflers, or noise-reduction features.

Source: Bolt, Beranek and Newman, U.S. EPA, Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances, 1971

Sounding locomotive horns or whistles in advance of highway-rail grade crossings has been used as a safety precaution by railroads since the late 1880s. The manner in which horns have been sounded (two longs, one short and one long) was standardized in 1938. In response to a growing national trend towards restrictions on the use of locomotive horns under local ordinances and a related increase in collisions, Congress passed the Swift Rail Development Act, which directed the Federal Railroad Administration to develop rules addressing this issue. On December 18, 2003, the Federal Railroad Administration published an Interim Final Rule that requires the use of locomotive horns or whistles when approaching road/rail grade crossing, except in approved quiet zones, where supplementary safety measures have been installed or adopted by the state or locality. The rule establishes that a horn sound level must be a minimum of 96 dBA and no louder than 110 dBA measured 100 feet in front of the locomotive and 15 feet above the rail. The rule is effective on December 18, 2004.[7]

The Federal truck passby noise standard is 80 dBA at 15 meters from the vehicle pathway centerline (trucks more than 4.5 tons, gross vehicle weight rating, under 40 CFR, Part 205, Subpart B). This standard is implemented through regulatory controls on truck manufacturers. Under regulations established by the Federal Highway Administration, noise abatement must be considered for federal or federally-funded projects involving the construction of a new highway or significant modification of an existing freeway. Abatement is considered when the project would result in a substantial noise increase or when the predicted noise levels approach or exceed the Noise Abatement Criteria (23 CFR Part 772). Under these criteria, a *substantial increase* is defined as a 12 dBA increase in the L_{eq} during the traffic peak hour. The Noise Abatement Criteria differ among various activity categories and between exterior spaces and interior spaces. For sensitive uses, such as residences, schools, churches, parks, and playgrounds, the Noise Abatement Criteria for interior and exterior spaces during the traffic peak hour is 52 and 67 L_{eq}, respectively.

State Regulations

The State of California establishes noise limits for vehicles licensed to operate on public roads. For heavy trucks, the passby standard is consistent with the federal limit of 80 dBA. The State passby standard for light trucks and passenger cars (less than 4.5 tons, gross vehicle rating) is also 80 dBA at 15 meters from the centerline.[8] These controls are implemented through controls on vehicle manufacturers and by legal sanction of vehicle operators by state and local law enforcement officials. Caltrans uses FHWA Noise Abatement Criteria to evaluate noise impacts.

The State of California has also established noise insulation standards for new multi-family residential units, hotels, and motels that would be subject to relatively high levels of transportation-related noise. These requirements are collectively known as the California Noise Insulation Standards and are found in *California Code of Regulations*, Title 24. These standards set forth an interior standard of 45 DNL in any habitable room. It requires an acoustical analysis demonstrating building design to meet this interior standard where the project site is subject to

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[7] Federal Railroad Administration, *Federal Register*, December 18, 2003.

[8] California Vehicle Code, §23130 and 23130.5; 27150, *et seq*.; 27204 and 27206.

noise levels greater than 60 DNL. Title 24 standards are typically enforced by local jurisdictions through the building permit process.

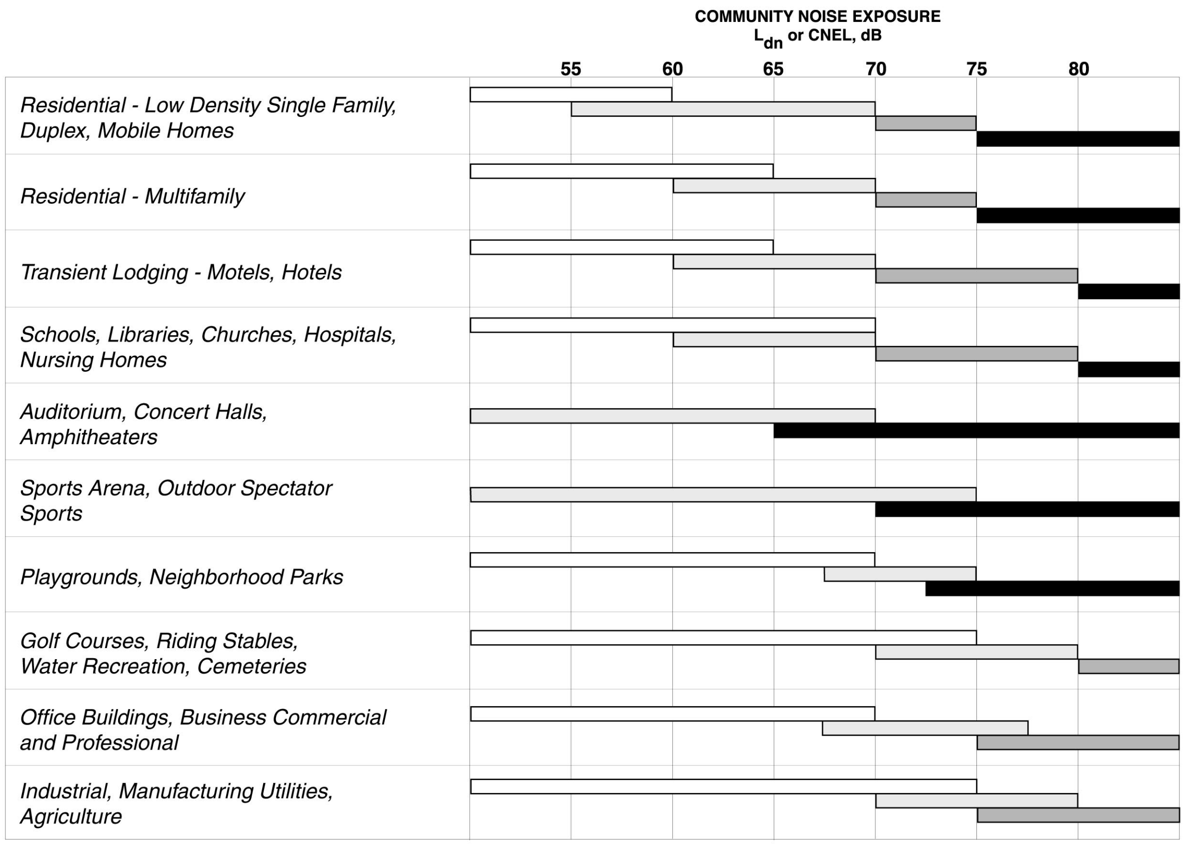
Local Regulations

To identify, appraise, and remedy noise problems in the local community, each county and city in the Bay Area is required to adopt a Noise Element as part of its General Plan. Each Noise Element is required to analyze and quantify, to the extent practicable, current and projected noise levels associated with local noise sources. These sources include, but are not limited to, highways and freeways, primary arterials and major local streets, rail operations, air traffic, local industrial plants, and other stationary sources that contribute to the community noise environment.

Beyond statutory requirements, local jurisdictions are free to adopt their own goals and policies in their Noise Elements. However, most jurisdictions have chosen to adopt noise/land use compatibility policies derived from State recommendations. For instance, most jurisdictions have adopted noise/land use compatibility guidelines that are similar to those recommended by the State (see Figure 2.5-2).

For residential uses, outdoor noise levels of less than 60 DNL or less are considered "normally acceptable"; outdoor noise levels between 60 and 70 DNL are "conditionally acceptable"; and outdoor noise levels exceeding 70 DNL are "normally unacceptable." Under State guidelines, new schools, libraries, churches, hospitals, and nursing homes that are proposed in areas subject to DNL 60 to 70 dBA should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. For many land uses, the State recommendations show overlapping DNL ranges for two or more compatibility categories. These overlapping DNL ranges indicate that local conditions (existing noise levels and community attitudes toward dominant noise sources) should be considered in evaluating land use compatibility at specific locations.

In addition to regulating noise through implementation of noise element policies, local jurisdictions regulate noise through enforcement of local ordinance standards. These standards generally relate to noisy activities (e.g., use of loudspeakers and construction) and stationary noise sources and facilities (e.g., air conditioning units and industrial activities). Generally, federal and state laws preempt local agencies from establishing noise standards for transportation-related noise sources, such as aircraft, ships, trains, and motor vehicles.



LEGEND:

NORMALLY ACCEPTABLE
Specified land use is satisfactory, based upon the assumption that any building involved is of normal conventional construction, without any special noise insulation requirements.

CONDITIONALLY ACCEPTABLE
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

NORMALLY UNACCEPTABLE
New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

CLEARLY UNACCEPTABLE
New construction or development should generally not be undertaken.

Source: Environmental Science Associates, 2001.

Figure 2.5-2
Noise and Land Use Compatibility Matrix Guidelines

IMPACT ANALYSIS

SIGNIFICANCE CRITERIA

This EIR uses the following criteria to assess whether the transportation improvements in the proposed Transportation 2030 Plan will have a significant adverse effect on the community noise environment:

- **Criterion 1: Construction.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if the construction of transportation projects results in exposure of persons to or generation of noise levels in excess of standards established in the applicable local general plan or noise ordinance standards.
- **Criterion 2: Freeways and Other Roadways.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if it results in noise levels that approach or exceed the FHWA Noise Abatement Criteria or increase substantially above existing levels (a 3 dBA change would be considered noticeable and significant for the purposes of this EIR).
- **Criterion 3: Rail Transit.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if it results in noise levels that increase by more than the allowable noise exposure permitted under the Federal Transit Administration (FTA) criteria, as shown in Table 2.5-4, below.

Table 2.5-4: Rail Transit Noise Impact Criteria: Effect on Cumulative Noise Exposure

DNL or Leq in dBA (rounded to nearest whole decibel)			
Existing Noise Exposure	*Allowable Project Noise Exposure*	*Allowable Combined Total Noise Exposure*	*Allowable Noise Exposure Increase*
45	51	52	7
50	53	55	5
55	55	58	3
60	57	62	2
65	60	66	1
70	64	71	1
75	65	75	0

Source: Office of Planning, Federal Transit Administration, Transit Noise and Vibration Impact Assessment. Final Report, April 1995

METHOD OF ANALYSIS

Since noise is a highly localized impact, specific and detailed analyses are most appropriate at the project level. Therefore, in this program EIR, the method to assess noise impacts of the proposed Transportation 2030 Plan is to review the list of proposed transportation improvements and assess the likelihood of potentially significant noise impacts based on the type of project, location, and general land uses surrounding the project. A doubling of traffic on a road is generally required to increase noise levels by a perceptible level, which is 3 dBA. For the purposes of this EIR, a 3dBA noise level increase is considered a significant noise impact. Subsequent project-specific environmental review will be required to further analyze these proposed improvements to determine the magnitude of noise and vibration impacts, and to identify appropriate potential mitigations for each individual project.

While the criteria for determining potentially adverse impacts apply to specific projects in the proposed Transportation 2030 Plan, a comparison of the roadway noise impacts on a county-wide and Bay Area-wide basis provides for a meaningful comparison of the overall effects of the proposed Transportation 2030 Plan and No Project alternative relative to the existing conditions (2000).

Noise associated with highway and other roadway traffic is dependent on a number of variables including:

- Traffic volume;
- Motor vehicle speed;
- Motor vehicle fleet mix (cars, trucks, etc.);
- Presence or absence of intervening barriers (e.g., earthen berms or sound walls); and,
- Location of the roadway with respect to sensitive receptors.

Noise from roadway traffic is generally measured in terms of one-hour equivalent steady-state sound levels that contain the same acoustic energy as a time-varying sound level (L_{eq1h}). Following Federal Highway Administration (FHWA) guidance, noise impacts occur when predicted noise levels increase substantially compared to existing levels, or when noise levels approach or exceed the FHWA's noise abatement criteria (NAC).

To evaluate the proposed Transportation 2030 Plan, the existing condition (2000) was compared with the future 2030 No Project and 2030 Project scenarios. The comparisons were accomplished by querying the GIS data maintained by MTC using SAS Software scripts to develop results for each alternative and scenario. SAS Software is a data management, analysis and presentation tool. Specifically, it is a querying tool used to pull data from a data set based on specified parameters and is used to produce queries, reports and/or interpret the results of data analysis. For the purposes of this EIR, SAS Software was used to extract data (including vehicle speed, volume, and fleet mix data, as well as segment length and type data) and to manipulate the data by integrating traffic noise modeling equations and principles to predict noise levels at specified distances from the roadway centerlines in order to determine where potential noise impacts could occur.

Noise level predictions were made for the entire modeled roadway network using the FHWA Noise Prediction Model adjusted to reflect California Vehicle Noise (Calveno) Reference Energy Mean Emissions Levels developed by Caltrans. For this modeling effort, average weekday a.m. peak hour traffic volumes and speeds were used. Estimated noise levels correspond to a distance of 100 feet from the centerline of the roadway. The modeling effort looked at directional miles and added 3 dBA to the calculated noise level to account for traffic traveling in the opposite direction for a given roadway segment. This approach conservatively doubles the traffic volumes for noise estimation purposes. The analysis also does not take into account surrounding land uses; it is assumed that sensitive receptors could be located within 100 feet of the roadway centerline for all modeled roadway segments.

First, the evaluation identifies the potential for absolute noise impacts. Following guidance published by Caltrans and the FHWA, a noise impact is determined to occur if predicted noise levels approach the NAC for noise sensitive land uses by 1 dBA; 66 dBA is the threshold for potentially significant noise impacts. The analysis estimates the number of roadway miles under each scenario where noise levels would be equal to or greater than 66 dBA at a distance of 100 feet from the centerline of the roadway. Table 2.5-5 identifies the total miles of potentially impacted roadways (freeways, expressways, and arterials) that would result in noise levels exceeding 66 dBA for each County and the Bay Area as a whole for existing conditions (2000), 2030 No Project, and 2030 Proposed Project (Transportation 2030 Plan) scenarios.

Secondly, the entire network of roadways was evaluated to determine whether there would be an anticipated increase of 3 dBA or more from existing conditions (2000). Table 2.5-6 shows the results of this analysis.

Table 2.5-5: Roadway Directional Miles > 66 dBA NAC Level, and Total Directional Miles, by Roadway Type and County (2000 to 2030)

		2000			2030 No Project			Net Change From 2000			2030 Project			Net Change From 2000		
County	*Roadway Type*	*# over 66 dBA*	*Total*	*% over 66 dBA*	*# over 66 dBA*	*Total*	*% over 66 dBA*	*# over 66 dBA*	*Total*	*% over 66 dBA*	*# over 66 dBA*	*Total*	*% over 66 dBA*	*# over 66 dBA*	*Total*	*% over 66 dBA*
San Francisco	Freeways	52	53	99.2%	52	53	99.2%	0	0	0.0%	52	53	99.2%	0	0	0.0%
	Expressways	1	2	43.6%	1	2	43.6%	0	0	0.0%	1	2	43.6%	0	0	0.0%
	Arterials	17	631	2.6%	26	633	4.0%	9	2	1.4%	27	633	4.3%	11	2	1.7%
San Mateo	Freeways	164	170	96.9%	165	170	96.9%	0	0	0.1%	164	170	96.7%	0	0	-0.2%
	Expressways	12	31	36.6%	16	31	49.7%	4	0	13.1%	15	31	49.2%	4	0	12.6%
	Arterials	6	1,062	0.6%	9	1,130	0.8%	3	68	0.2%	9	1,130	0.8%	3	68	0.2%
Santa Clara	Freeways	311	318	97.8%	319	326	97.9%	7	7	0.1%	325	333	97.7%	14	14	0.0%
	Expressways	124	240	51.8%	160	235	68.2%	36	-6	16.4%	156	228	68.3%	31	-13	16.5%
	Arterials	76	2,065	3.7%	117	2,067	5.7%	41	2	2.0%	113	2,073	5.5%	38	9	1.8%
Alameda	Freeways	302	305	99.0%	298	305	97.9%	-4	0	-1.2%	302	305	99.0%	0	0	0.0%
	Expressways	13	36	37.6%	21	45	46.3%	7	9	8.7%	23	45	51.1%	9	9	13.5%
	Arterials	62	1,782	3.5%	86	1,811	4.7%	24	29	1.3%	92	1,817	5.1%	30	34	1.6%
Contra Costa	Freeways	192	194	99.1%	183	184	99.4%	-9	-10	0.3%	193	195	98.8%	1	1	-0.2%
	Expressways	2	17	13.0%	25	45	54.7%	22	28	41.8%	15	34	42.2%	12	18	29.2%
	Arterials	23	1,532	1.5%	41	1,551	2.6%	18	19	1.1%	41	1,554	2.6%	17	22	1.1%
Solano	Freeways	167	171	97.7%	171	174	98.3%	4	3	0.6%	171	174	98.3%	4	3	0.6%
	Expressways	37	49	76.1%	35	60	58.3%	-3	11	-17.8%	38	72	52.7%	1	23	-23.4%
	Arterials	34	732	4.7%	60	734	8.2%	26	2	3.5%	60	742	8.1%	26	10	3.4%
Napa	Freeways	10	10	100.0%	24	24	100.0%	14	14	0.0%	24	24	100.0%	14	14	0.0%
	Expressways	44	47	92.8%	35	37	93.3%	-9	-10	0.6%	37	37	99.0%	-7	-10	6.3%
	Arterials	13	488	2.8%	40	484	8.3%	27	-4	5.5%	40	484	8.3%	27	-4	5.5%
Sonoma	Freeways	131	131	100.0%	132	132	99.7%	1	1	-0.3%	132	132	100.0%	1	1	0.0%
	Expressways	15	20	75.9%	16	20	76.6%	0	0	0.7%	16	20	76.6%	0	0	0.7%
	Arterials	6	1,136	0.5%	14	1,160	1.2%	8	24	0.7%	15	1,161	1.3%	9	25	0.8%
Marin	Freeways	77	77	100.0%	77	77	99.6%	0	0	-0.4%	77	77	100.0%	0	0	0.0%
	Arterials	7	555	1.3%	9	559	1.6%	2	4	0.3%	8	560	1.5%	1	5	0.2%
Bay Area	Freeways	1,407	1,428	98.5%	1,420	1,444	98.4%	13	16	-0.1%	1,441	1,462	98.5%	34	34	0.0%
	Expressways	248	442	56.2%	307	475	64.6%	58	32	8.4%	299	469	63.8%	51	27	7.6%
	Arterials	244	9,982	2.4%	401	10,129	4.0%	156	147	1.5%	405	10,154	4.0%	161	172	1.5%
	Combined	1,900	11,853	16.0%	2,127	12,047	17.7%	228	195	1.6%	2,146	12,086	17.8%	246	233	1.7%

Source: Environmental Science Associates, 2004; Metropolitan TransportationCommission, 2004

Table 2.5-6: Roadway Directional Miles with Significant Increase in Noise Levels (> 3 dBA), 2000 to 2030 No Project and 2030 Project Scenarios

		2030 No Project			*2030 Project*		
County	*Roadway Type*	*> 3 dBA Increase*	*Total*	*% with > 3 dBA increase*	*> 3 dBA Increase*	*Total*	*% with > 3 dBA increase*
San Francisco	Freeways	0	53	0.0%	2	53	4.3%
	Expressways	<1	2	28.2%	<1	2	28.2%
	Arterials	88	625	14.0%	93	625	14.8%
San Mateo	Freeways	1	170	0.8%	7	170	4.3%
	Expressways	6	31	19.2%	6	31	18.4%
	Arterials	137	1,124	12.2%	144	1,124	12.8%
Santa Clara	Freeways	20	321	6.4%	41	328	12.6%
	Expressways	28	235	11.9%	21	228	9.3%
	Arterials	498	2,059	24.2%	372	2,060	18.1%
Alameda	Freeways	4	305	1.4%	7	305	2.2%
	Expressways	8	35	22.1%	11	35	31.2%
	Arterials	398	1,772	22.5%	276	1,773	15.6%
Contra Costa	Freeways	3	180	1.6%	15	190	7.7%
	Expressways	7	27	27.1%	8	17	50.0%
	Arterials	417	1,531	27.2%	332	1,531	21.6%
Solano	Freeways	5	171	2.9%	6	171	3.5%
	Expressways	14	57	24.9%	17	59	28.7%
	Arterials	233	715	32.5%	220	713	30.9%
Napa	Freeways	12	24	51.5%	11	24	48.5%
	Expressways	2	37	5.2%	0	37	0.0%
	Arterials	99	484	20.4%	57	484	11.8%
Sonoma	Freeways	6	120	4.8%	11	120	9.4%
	Expressways	0	20	0.0%	0	20	0.0%
	Arterials	151	1,119	13.5%	106	1,119	9.4%
Marin	Freeways	0	77	0.0%	11	77	14.5%
	Arterials	44	555	7.9%	34	555	6.1%
Bay Area	Freeways	52	1,418	3.7%	112	1,435	7.8%
	Expressways	66	444	14.8%	64	430	14.9%
	Arterials	2,063	9,984	20.7%	1,634	9,985	16.4%
	Combined	2,181	11,847	18.4%	1,809	11,849	15.3%

Source: Environmental Science Associates, 2004; Metropolitan Transportation Commission, 2004

SUMMARY OF IMPACTS

Direct Impacts

Implementation of transportation improvements in the proposed Transportation 2030 Plan could result in both short- and long-term impacts on noise levels in the nine-county San Francisco Bay Area.

Short Term Impacts

Many of the transportation improvements in the proposed Transportation 2030 Plan would entail construction, which could generate localized, short-term noise impacts, depending on the location and proximity of noise-sensitive land uses.

Long Term Impacts

Both Tables 2.5-5 and 2.5-6 show that noise levels will increase for both the 2030 No Project and 2030 Proposed Project scenarios relative to 2000 conditions. Numerous transportation improvements in the proposed Transportation 2030 Plan have been identified as having potentially significant local noise impacts, either from vehicle or rail travel. It should be noted that noise mitigation for these new projects may reduce noise in communities that would otherwise continue to experience adverse noise impacts from existing and future traffic had not the proposed Transportation 2030 Plan improvements occurred.

Indirect/Cumulative Impacts

The growth in traffic throughout the Bay Area could produce cumulative noise impacts that would increase noise in some locations, depending on the local setting. Noise levels may or may not reach thresholds for perceptible increases as defined above.

IMPACTS & MITIGATION

Impact

2.5-1 **Construction of the transportation improvements proposed in the Transportation 2030 Plan would have short-term noise impacts on surrounding areas.** ***(Significant, mitigable)***

Many of the transportation improvements in the proposed Transportation 2030 Plan would entail construction, often using heavy equipment. Depending on the proximity of such activities to noise sensitive uses, construction activities associated with individual projects could generate localized, short term noise impacts from excavation, grading, hauling, concrete pumping, and a variety of other activities requiring the operation of heavy equipment. In these cases, construction of individual projects could cause exposure of persons to or generation of noise levels in excess of standards established in the applicable local general plan or noise ordinance standards.

Mitigation Measures

2.5(a) Project sponsors shall commit to mitigation measures at the time of certification of each environmental document and at the time of project approval. Construction noise mitigation normally required by Caltrans' *Standard Specifications and Standard Special Provisions*, as well as local city and county ordinances shall be implemented for individual Transportation 2030 Plan projects that include physical construction activities. Construction mitigation measures generally limit construction activities to times when construction noise would have the least effect on adjacent land uses, and would require such measures as properly muffling equipment noise, locating equipment as far from sensitive receptors as possible, and turning off equipment when not in use. Some jurisdictions may also have property line or other noise level limits that must be adhered to during construction.

These mitigation measures would be expected to reduce potentially significant construction-related noise impacts to a less-than-significant level if incorporated by project sponsors.

Impact

2.5-2 **Transportation improvements proposed as part of the Transportation 2030 Plan could result in noise levels that approach or exceed the FHWA and FTA Noise Abatement Criteria or that could cause noise levels to increase by 3 dBA or more.** ***(Significant, mitigable)***

Transportation improvements that could contribute to increased noise levels include new roadways, roadway realignments, addition of highway lanes and ramps, and use of new transit facilities as well as increased use of existing transit facilities.

Referring back to Table 2.5-5, nearly all freeway miles on the modeled roadway network under each of the three scenarios exceed the NAC for noise-sensitive uses of 66 dBA. Roadway noise levels along expressways would be most affected by implementation of the 2030 Proposed Project and No Project alternative; for the region as a whole, the 2030 Proposed Project and the No Project alternative would increase the percentage of roadway miles that met the 66 dBA criterion by 8.4% and 7.6%, respectively. The percentage of arterials that meet the 66 dBA criterion would also increase under future scenarios.

Table 2.5-6 shows that both the 2030 No Project and 2030 Proposed Project scenarios would increase the percentage of roadway miles where noise levels would increase by 3 dBA or more relative to 2000 conditions.

A number of transportation improvements in the proposed Transportation 2030 Plan have been identified as having potentially significant local noise impacts, either from vehicle or rail travel. Direct impacts could result from new transit lines (noise and ground borne vibration), widening of freeways, expressways or arterials that brings noise closer to sensitive land uses, or addition of new lanes that result in higher traffic volumes and speeds. Project-level analysis may or may not find significant noise impacts depending upon the project and the existing or projected land use.

Table 2.5-7, which appears at the end of this chapter, lists individual transportation improvements in the proposed Transportation 2030 Plan that have the potential to create a significant noise impact since they could trigger significance criterion 2 or 3, as defined above, related to either roadway or rail. It should be noted that the list of projects in Table 2.5-7 are indicative of projects most likely to generate potentially significant noise impacts due to facility operation, but the list is neither exhaustive nor definitive. Each of the projects included in the proposed Transportation 2030 Plan would be subject to subsequent project-specific environmental review.

Mitigation Measures

Project sponsors shall commit to mitigation measures at the time of certification of their environmental document. Noise mitigation measures must respond to local land use compatibility criteria, and, if federal funding is used for the project, mitigation measures must also conform to applicable FHWA or FTA noise abatement criteria. These commitments obligate project sponsors to implement measures that would minimize or eliminate any significant impacts. Typical mitigation measures that should be considered by project sponsors include:

2.5(b) Construction of sound walls adjacent to new or improved roads or transit lines. Noise level increases could, in most cases, be mitigated to levels at or below existing levels if sound walls were constructed along the rights-of-way. A determination of the specific heights, lengths, and feasibility of sound walls must be part of the project-level environmental assessment. Caltrans will evaluate the feasibility of sound walls based on the height required to attenuate noise, the number of people protected, and the cost of the sound wall. It is likely that FHWA noise abatement criteria would be met if sound walls are included along the identified projects. Where the proposed Transportation 2030 Plan would improve existing roadways, sound walls would also result in a reduction of overall sound levels, even considering potential increases from road widenings and additional traffic. As a result, the implementation of this mitigation measure can avoid project noise impacts *and* reduce existing noise levels along a number of heavily-traveled corridors in the region.

2.5(c) Adjustments to proposed roadway or transit alignments to reduce noise levels in noise sensitive areas. For example, depressed roadway alignments can effectively reduce noise levels in nearby areas.

2.5(d) Insulation of buildings or construction of noise barriers around sensitive receptor properties.

- Vibration isolation of track segments.
- Use of local land use policies by local agencies to guide the location of noise sensitive uses to sites away from roadways and rail corridors.

As noted, the implementation of noise mitigation will, in some cases, more than offset the noise impacts of a particular transportation improvement. As a result, the proposed Transportation 2030 Plan has the potential to bring noise abatement benefits to communities that currently experience noise problems resulting from existing traffic.

These mitigation measures would be expected to reduce potentially significant noise impacts to a less-than-significant level if incorporated by project sponsors.

Cumulative Impact

2.5-3 **Forecast population and employment will result in increased traffic volumes in individual counties in the Bay Area and could, in turn, increase noise levels along some of the travel corridors in those counties.** ***(Significant, unavoidable)***

Cumulative Growth that would be served by transportation improvements in the proposed Transportation 2030 Plan will result in cumulative noise impacts in some locations. The significance of this cumulative effect will vary, depending on the location, degree of traffic increase, and proximity of sensitive land uses.

Mitigation Measures

Except where future transportation improvements create the need for noise mitigation, increased noise in other parts of the Bay Area would not necessarily be mitigated unless communities and local transportation authorities: 1) determine that a noise problem exists and that the problem is one of a perceptible nature, and 2) identify local or other transportation funds not currently included in the proposed T2030 Plan to provide the necessary mitigation. In many corridors, the projected traffic increases are unlikely to produce perceptible increases in noise since there may not be any sensitive receptors nearby and the increased volumes would not trigger a significant impact.

These mitigation measures are not expected to reduce all potentially significant cumulative noise impacts to a less-than-significant level, since there may be locations where a current or future problem exists and there is no funding identified to provide the necessary mitigation.

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
20001	Santa Clara Co-wide	V	US 101/Bailey Ave I/C improvements
21030	Alameda Co-wide	N	I-580/US 101 I/C impvts and new fwy-to-fwy connectors from WB I-580 to NB and SB US 101
21036	Alameda Co-wide	N	Selected add'l I-680 aux lns south of I-680/Rte 24 I/C
21066	Region	N	California High-Speed Rail with terminal in San Francisco
21093	Alameda Co-wide	N	Rte 92/Clawiter Rd/Whitesell St I/C improvements
21100	Alameda Co-wide	N	I-580/Vasco Rd I/C improvements
21101	Alameda Co-wide	N	Extend Tinker Ave from Webster St to 5th Ave
21103	Eastshore-North	V	Central Ave railRd overpass
21105	Eastshore-North	V	I-580/Isabel I/C improvements (Phases 1 and 2)
21107	Eastshore-North	V	I-880/High St I/C improvements
21114	Eastshore-North	V	Washington/Paseo Padre Parkway Grade Separation
21123	Eastshore-North	V	Union City Intermodal Sta infrastructure impvts (Phase 2)
21131	Eastshore-North	N	BART-Oakland International Airport connector)
21132	Eastshore-North	N	BART extension to Warm Springs
21185	Eastshore-South	V	Extend Eden Rd from Doolittle Dr to city of San Leandro water pollution control plant
21205	Eastshore-South	N	I-680/Rte 4 I/C fwy-to-fwy direct connectors: EB Rte 4 to SB I-680, and NB I-680 to WB Rte 4 (Phases 1 and 2)
21206	Eastshore-South	N	Caldecott Tunnel fourth bore
21209	Eastshore-South	N	Hercules Transit Center relocation and expansion
21210	Eastshore-South	N	Capitol Corridor train station in Hercules
21211	Eastshore-South	N	BART/East Contra Costa rail extension
21212	Eastshore-South	N	Construct aux ln along EB Rte 4 and widen Hillcrest Ave EB off-ramp to 2 lns
21214	Eastshore-South	N	Widen Wilbur Ave over Burlington Northern Santa Fe Rail Rd to 4 lns
21216	Eastshore-South	N	Extend Laurel Rd from Rte 4 Bypass to Empire Ave
21306	Eastshore-South	N	US 101/Lucas Valley Rd I/C improvements (initial phase)
21317	Eastshore-South	N	Widen Rte 1 from US 101 to Flamingo Rd
21325	Eastshore-South	N	US 101/Greenbrae I/C improvements
21326	Eastshore-South	N	US 101/Tiburon Blvd I/C improvements (remaining phases)
21334	Eastshore-South	V	US 101/Lucas Valley Rd I/C improvements (remaining phases)
21342	Fremont-So. Bay	V	Caltrain downtown ext/Transbay Terminal replacement
21348	Fremont-So. Bay	C	Install a second span along existing Green Valley Bridge
21349	Fremont-So. Bay	C	US 101/Ralston Ave I/C improvement
21455	Fremont-So. Bay	C	Widen I-238 /b/ I-580 and I-880 to 6 lns and aux lns on I-880 south of I-238
21456	Fremont-So. Bay	C	I-580 aux lns between Santa Rita Rd/Tassajara Rd and Airway Blvd I/Cs
21466	Fremont-So. Bay	C	Washington Ave/Beatrice St I/C improvements
21467	Fremont-So. Bay	C	Extend Westgate Parkway along eastern edge of Westgate Shopping Center between Williams St and Davis St

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
21472	Fremont-So. Bay	C	I-680/Bernal Ave I/C improvements
21473	Fremont-So. Bay	N	Construct a 4-ln mjr arterial connecting Dublin Blvd and North Canyons Pwy
21475	Fremont-So. Bay	N	I-580/First St I/C improvements
21477	Fremont-So. Bay	N	I-580/Greenville Rd I/C improvements
21482	Fremont-So. Bay	N	Exend Fremont Blvd to connect to I-880/Dixon Landing Rd
21483	Fremont-So. Bay	N	Widen Stevenson Blvd from I-880 to Blacow Rd from 4 lns to 6 lns
21484	Fremont-So. Bay	N	Widen Kato Rd from Warren Ave to Milmont Dr
21487	Sunol Gateway	C	Widen Mowry Ave from Mission Blvd to Peralta Blvd
21489	Sunol Gateway	N	I-580/San Ramon Rd/Foothill Rd I/C improvements
21492	Sunol Gateway	N	Extend Scarlett Dr from Dublin Blvd to Dougherty Rd
21510	Tri-Valley	V	Third St light-rail transit extension to Chinatown, Phase 2 (Central Subway)
21602	Tri-Valley	C	US 101/BRdway I/C reconstruction
21603	Tri-Valley	C	US 101/Woodside Rd I/C improvements
21604	Tri-Valley	C	US 101 aux lns from Sierra Point to San Francisco Co line
21605	Tri-Valley	C	US 101/Oyster Point Blvd I/C improvements (Phases 2 and 3)
21606	Tri-Valley	C	US 101/ Willow Rd I/C reconstruction
21607	Tri-Valley	C	US 101/University Ave I/C reconstruction
21608	Tri-Valley	C	US 101 NB and SB aux lns from Marsh Rd to Santa Clara Co line
21609	Tri-Valley	C	I-280/I-380 local access impvts from Sneath Ln and San Bruno Ave to I-380
21610	Tri-Valley	C	US 101 aux lns from San Bruno Ave to Grand Ave
21612	Tri-Valley	C	Improvement of Dumbarton Bridge access to US 101 (Phase 1)
21613	Tri-Valley	N	Rte 92 impvts from San Mateo Bridge to I-280; includes uphill passing ln from US 101 to I-280 (Phase 1)
21615	Tri-Valley	N	I-280/Rte 1 I/C safety improvements (initial phase)
21617	Tri-Valley	N	Caltrain Express service between San Francisco and San Jose; includes passing tracks and rolling stock (Phase 1)
21618	Tri-Valley	N	Dumbarton rail corridor (Phase 1)
21619	Tri-Valley	N	Caltrain express tracks (Phase 2)
21626	Tri-Valley	N	Caltrain grade separation program (San Mateo Co)
21702	Eastshore-North	C	US 101/Buena Vista Ave I/C construction
21703	Eastshore-North	C	I-880/Coleman Ave I/C improvements
21704	Eastshore-North	C	Improve I-280 downtown access between 3rd St and 7th St
21705	Eastshore-North	C	Rte 237/El Camino Real/Grant Rd intersection improvements
21708	Eastshore-South	V	Add I-280 NB braided ramps between Foothill Expressway and Rte 85
21713	Golden Gate	V	Construct aux ln on EB Rte 237 from North First St to Zanker Rd
21714	Golden Gate	V	Widen US 101 /b/ Monterey Hwy and Rte 25 (includes an ext to Santa Teresa Blvd) and construct a full I/C at US 101/Rte 25/Santa Teresa Blvd
21715	Golden Gate	C	Rte 152/Rte 156 I/C improvements
21716	Golden Gate	C	Widen Rte 237 to 6 lns for HOV lns /b/ Rte 85 and east of Mathilda Ave

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
21717	Golden Gate	C	Widen Rte 25 from US 101 to Rte 156 to 6 lns (includes new I/C at Rte 156)
21718	Peninsula	N	Rte 85 NB and SB aux lns between Homestead Ave and Fremont Ave
21719	Peninsula	N	I-880/I-280/Stevens Creek Blvd I/C improvements (Phase I)
21720	Region	V	US 101/Tennant Ave I/C improvements
21722	Region	V	US 101 SB Trimble Rd/De La Cruz Blvd/Central Expressway I/C impvts
21723	Region	V	US 101/Tully Rd I/C modifications
21724	Region	V	Widen US 101 for NB and SB aux ln from Trimble Rd to Montague Expwy
21727	Region	V	Rte 87/US 101 ramp connection to Trimble Rd I/C
21749	Region	C	Extend Butterfield Blvd from Tennant Ave to Watsonville Rd
21760	Region	C	Double-track segments of the Caltrain line between San Jose and Gilroy
21770	Region	C	Extend Caltrain from Gilroy to Salinas
21785	Region	N	US 101/Blossom Hill Rd I/C improvements
21786	Region	N	US 101/Hellyer Ave I/C modifications
21807	Region	N	Widen I-80 from I-680 to Air Base Parkway to 10 lns for HOV lns
21824	Region	N	Rte 12 from I-80 to Sacramento Bridge capacity and oper impvts
21884	Contra Costa Co-wide	V	Petaluma cross town connector/I/C
21886	Contra Costa Co-wide	V	Widen unimproved segment of Industrial Pwy /b/ Whipple Rd and improved segment of Industrial Pwy to 4 lns
21888	Contra Costa Co-wide	C	Construct flyover from Sanitary Landfill Rd east of US 101 to SB US 101
21892	Contra Costa Co-wide	C	Widen Rte 84 from 4 lns to 6 lns from El Camino Real to BRdway
21896	Contra Costa Co-wide	N	Rte 84 vertical and horizontal alignment impvts in Fremont
21902	Contra Costa Co-wide	N	Widen US 101 for HOV lns from Old Redwood Hwy to Rohnert Pk Expwy
21922	Contra Costa Co-wide	N	San Jose International Airport connections to Guadalupe LRT
22002	Delta	V	Extend HOV ln on I-880 NB from existing HOV terminus at Bay Bridge approach to Maritime on-ramp
22003	Delta	V	Capitol Corridor: Phase 2 enhancements
22005	Delta	V	ACE service expansion to eight (8) trains
22009	Delta	V	Capitol Corridor intercity rail service (track capacity/frequency impvts from Oakland to San Jose
22010	Delta	C	Construct I-280 NB second exit ln to Foothill Expressway
22011	Delta	C	BART/East Contra Costa rail extension (Construction)
22012	Delta	C	Rte 237 EB aux ln improvement from North First St to Zanker Rd
22013	Delta	C	I-580 corridor improvements
22016	Delta	C	Various HOV ln gap closures to complete the HOV/HOT network
22017	Delta	C	Construct Rte 237 EB to Mathilda Ave flyover off-ramp
22018	Delta	C	US 101/Mathilda Ave I/C improvements
22019	Delta	C	Downtown E Valley: Santa Clara/Alum Rock and Capitol Expwy to Nieman
22020	Delta	C	US 101 NB braided ramps between Capitol Expressway and Yerba Buena Rd
22022	Delta	C	Palo Alto Smart Residential Arterials

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22038	Delta	C	San Francisco-Oakland Bay Bridge toll plaza HOV bypass lns
22042	Delta	C	Widen I-680 for NB HOV ln from Rte 237 to Stoneride Dr
22063	Delta	N	Rte 238 corridor improvements between Foothill Blvd/Mattox Rd to Mission Blvd/Industrial Pwy
22064	Delta	N	Convert SB HOV ln on I-680 /b/ Rte 84 and Rte 237 into HOT ln
22082	Diablo	V	Reconstruct 7th St/Union Pacific RailRd grade separation
22084	Diablo	V	Oakland International Aiport North Field access Rd
22085	Diablo	V	Various grade separations at Union Pacific RailRd tracks
22088	Diablo	V	I-580/I-680 I/C truck bypass lns
22091	Diablo	V	Upgrade Rte 152 to a limited access 4-ln fwy
22106	Diablo	V	Extend Whitesell St as a 4-ln arterial from Enterprise to Depot Rd
22118	Diablo	C	Extend Hill Rd to Peet Ave
22127	Diablo	C	Rte 85 NB and SB aux lns from Stevens Creek Blvd to Saratoga/Sunnyvale Rd
22128	Diablo	C	Rte 85 NB and SB aux lns from Saratoga/Sunnyvale Rd to Saratoga Ave
22130	Diablo	C	Rte 85 NB and SB aux lns from Saratoga Ave to Winchester Blvd
22134	Diablo	C	Widen US 101 SB from Story Rd to Yerba Buena Rd
22138	Diablo	C	Widen US 101 to 4 lns from Rte 25 to Santa Clara/San Benito Co line
22140	Diablo	C	Widen US 101 between Cochrane Rd and Monterey Highway to 8 lns
22145	Diablo	N	Widen WB Rte 237 on-ramp from Rte 237 to NB US 101 to 2 lns and add aux ln on NB US 101 from Rte 237 on-ramp to Ellis St I/C
22147	Diablo	N	US 101 I/C at Zanker Rd/Skyport Dr/North Fourth St (Phase I)
22152	Diablo	N	Reconstruct Mathilda Ave bridge over Caltrain tracks and Evelyn Ave
22153	Diablo	N	Extend Mary Ave north across Rte 237
22156	Diablo	N	Rte 85 NB to SR 237 EB connector ramp improvements
22158	Eastshore North	C	Rte 85 aux lns between Fremont Ave and El Camino Real
22161	Eastshore North	C	Rte 85 aux lns between El Camino Real and Rte 237, and Rte 85/El Camino Real I/C improvements
22162	Eastshore-North	V	Rte 237 WB to Rte 85 SB connector ramp improvements
22164	Eastshore-North	V	Rte 237 WB on-ramp at Middlefield Rd
22165	Eastshore-North	V	US 101 SB to Rte 237 EB aux ln improvements (Phase 1)
22167	Eastshore-North	V	US 101 SB braided ramps between Capitol Expressway and Yerba Buena Rd
22169	Eastshore-North	V	Widen Coleman Ave from Hedding St and a future Autumn St extension from 4 lns to 6 lns
22170	Eastshore-North	V	Construct I-880 overcrossing on Charcot Ave between Paragon Dr and Old Oakland Rd as a reliever Rte to Montague Expressway and Brokaw Rd
22171	Eastshore-North	V	Extend Autumn St from Julian St to Coleman Ave to connect I-880 to west part of downtown San Jose
22175	Eastshore-North	V	Widen Almaden Expwy between Coleman Rd and Blossom Hill Rd to 8 lns
22176	Eastshore-North	V	Widen Berryessa Rd from I-680 to Commercial St from 4 lns to 6 lns
22177	Eastshore-North	V	Widen Branham Ln from Vista Park Dr to Snell Ave from 4 lns to 6 lns

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22178	Eastshore-North	V	Replace 4-ln structure with 6-ln bridge on Calaveras Blvd over Union Pacific RailRd from Abel St to Milpitas Blvd
22179	Eastshore-North	N	Widen Central Expwy /b/ Lawrence Expwy and San Tomas Expwy to 6 lns
22180	Eastshore-North	N	Widen Central Expressway between Lawrence Expressway and Mary Ave to provide aux acceleration and/or deceleration lns
22181	Eastshore-North	N	Construct 4-ln bridge over Guadalupe River /b/ Almaden Expressway and Fell Ave to connection sections of Chynoweth Ave
22183	Eastshore-North	N	Widen Lucretia Ave to 4 lns from Story Rd to Phelan Ave
22185	Eastshore-North	N	Widen Oakland Rd to 6 lns from US 101 to Montague Expressway
22186	Transbay Bay Bridge	V	Widen San Tomas Expressway between Rte 82 and Williams Rd to 8 lns
22191	Golden Gate	V	US 101/Airport Blvd I/C improvements
22192	Golden Gate	V	Widen Airport Blvd from 2 lns to 4 lns (also includes a center turn ln)
22193	Golden Gate	V	Construct Forestville bypass on Rte 116
22195	Golden Gate	V	Old Redwood Highway/US 101 I/C improvements
22197	Golden Gate	V	Penngrove local Rd improvements including RailRd Ave I/C
22204	Golden Gate	V	Widen Fulton Rd from Guerneville Rd to US 101 from 2 lns to 4 lns
22205	Golden Gate	V	US 101/Hearn Ave I/C impvts; including widening overcrossing and ramps
22206	Golden Gate	V	Construct Rte 12/Fulton Rd I/C
22207	Golden Gate	V	Extend Farmers Ln as a 3-ln or 4-ln arterial from Bellevue Ave to Rte 12
22224	Golden Gate	C	Caltrain and California High Speed Rail grade separations and sta in Atherton
22227	Golden Gate	C	Extend Geneva Ave from Bayshore Blvd to US 101/Harney ramps to 6 lns
22228	Golden Gate	C	Extend Lagoon Way to connect to US 101, Bayshore Blvd and Guadalupe Canyon Parkway
22229	Golden Gate	C	US 101/Sierra Point Parkway I/C replacement
22230	Golden Gate	N	Study of I-280 aux lns from I-380 to Hickey Blvd
22231	Golden Gate	N	Widen north side of John Daly Blvd/I-280 overcrossing for additional WB traffic ln and dedicated right-turn ln for SB I-280 off-ramp
22255	Marin Co-wide	C	Construct Ilinois St Intermodal Bridge across Islais Creek to connect to Port of San Francisco's Pier 80 cargo terminal
22271	Napa Co-wide	V	Widen Skyline Blvd (Rte 35) to 4-ln Rdway from I-280 to Sneath Ln
22273	Napa Co-wide	V	US 101/Candlestick I/C reconstruction (Phase 2)
22279	Napa Co-wide	V	US 101/Produce Ave I/C project
22282	Napa Co-wide	C	Widen US 101 SB by adding 5th ln from WB Rte 92 loop on-ramp to Ralston Ave off-ramp
22336	Napa Co-wide	C	Widen shoulders of Byron Highway and construct grade separation over Union Pacific RailRd tracks
22350	Napa Valley	V	I-680/Rte 4 I/C improvements (Phases 3 through 5) and HOV flyover ramps
22351	Napa Valley	V	I-680 NB HOV gap closure between North Main St and Rte 242
22352	Napa Valley	C	I-680/Norris Canyon Rd HOV direct ramps in San Ramon
22353	Napa Valley	C	I-680 SB HOV gap closure between North Main St and Livorna
22354	Napa Valley	C	I-680/Marina Vista I/C improvements

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22355	North Bay East-West	V	I-80/Central Ave I/C modifications
22358	North Bay East-West	N	I-80/Rte 4 I/C improvements
22382	San Francisco	V	Richmond Parkway/San Pablo Ave grade separated I/C
22388	San Francisco	V	Construct Rte 242/Clayton Rd NB on-ramp
22389	San Francisco	V	Construct Rte 242/Clayton Rd SB off-ramp
22390	San Francisco	V	Reconstruct Rte 4/Willow Pass Rd ramps in Concord
22392	San Francisco	V	Rte 4/Range Rd I/C construction
22400	San Francisco	V	Construct Rte 239 from Brentwood to Tracy Expressway
22412	San Francisco	N	Additional light rail vehicles (LRVs) to expand MUNI rail service
22415	San Francisco	N	Expand historic Stcar service (sales tax project)
22419	San Francisco	N	Widen US 101 for HOV lns from Lucky Dr to North San Pedro Rd
22422	San Francisco Co-wide	C	Widen Senter Rd between Tully Rd and Capitol Expressway to 6 lns
22424	San Francisco Co-wide	C	BART Advanced Automatic Train Control (AATC) Phase V
22429	San Francisco Co-wide	C	US 101/Manuel Freitas Parkway I/C improvements
22430	San Francisco Co-wide	C	Kerner Blvd/Francisco Blvd East/Andersen Dr underpass connector
22436	San Francisco Co-wide	V	US 101 SB aux ln from Lincoln to Mission
22437	San Francisco Co-wide	V	US 101 NB aux ln at Nave Dr
22438	San Francisco Co-wide	V	Bodega Highway improvements west of Sebastopol
22490	Peninsula	V	Convert bridges of Sonoma Co from one-ln to two-ln bridges
22513	Peninsula	V	Sonoma Marin Area Rail Transit District (SMART) commuter rail (construction only)
22600	Peninsula	V	Widen Somersville Rd Bridge in Antioch to 4 lns
22601	Peninsula	V	Rte 4 Bypass, Segment 3: construct a 2-ln facility from Balfour Rd to Walnut Blvd, and upgrade Marsh Creek Rd
22602	Peninsula	C	Construct I-680 aux lns in both directions from Sycamore Valley Rd to Crow Canyon Rd
22604	Peninsula	C	Construct safety and operational impvts (including potential realignment) on Vasco Rd from Brentwood to Alameda Co line
22605	Peninsula	C	Rte 4 Bypass, Segments 2 & 3: widen and upgrade to full fwy
22607	Peninsula	C	Major Sts widening, extensions and I/C improvements (East Co)
22609	Peninsula	C	Major Sts widening, extensions and I/C improvements (Central Co)
22610	Peninsula	C	Major Sts widening, extensions and I/C improvements (West Co)
22612	Peninsula	C	I-680/Sycamore Valley Rd direct HOV ramps in Danville
22613	Peninsula	C	Major Sts widening, extensions and I/C improvements (Southwest Co)
22622	Peninsula	C	Manor Dr/Rte 1 overcrossing widening and improvement project
22623	Peninsula	N	Widen Nut Tree overcrossing to 4 lns
22624	Peninsula	N	Construct continuous 4-ln Jepson Parkway from Suisun City to Vacaville
22625	Peninsula	N	I-80/North Texas St I/C improvements
22626	Peninsula	N	Rte 29/Rte 37 I/C improvements

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22630	Peninsula	N	Parkway Blvd overcrossing of Union Pacific RailRd grade separation
22631	Peninsula	N	Rte 12 WB (Red Top Rd) truck ln
22632	Peninsula	N	American Canyon Rd overpass at I-80
22633	Peninsula	N	Widen Azuar Dr/Cedar Ave from P St to Residential Parkway to 4 lns
22639	Peninsula	N	US 101/Mill St I/C in Healdsburg
22640	Peninsula	N	US 101/Shiloh Rd I/C in Windsor
22641	Peninsula	N	US 101/Baker I/C in Santa Rosa
22642	Peninsula	N	US 101/Dry Creek I/C in Healdsburg
22643	Peninsula	N	US 101/Mendocino Ave/Hopper Ave I/C
22644	Peninsula	N	US 101/Bellevue I/C
22646	Peninsula	N	US 101/River Rd I/C
22655	San Mateo Co-wide	V	Widen US 101 for HOV lns from Rohnert Park Expwy to Santa Rosa Ave
22656	San Mateo Co-wide	V	US 101/East Washington St I/C improvements
22657	San Mateo Co-wide	V	I-205/I-580 Altamont Pass WB truck ln
22660	San Mateo Co-wide	C	Widen I-880 by adding lanes between Whipple and Jackson
22664	San Mateo Co-wide	C	I-580 High Occupancy Toll (HOT) lns from Greenville Rd west to I-680
22666	San Mateo Co-wide	N	Rte 84 High Occupancy Toll (HOT) lns in Tri-Valley
22667	San Mateo Co-wide	N	Tri-Valley rail extension from Dublin/Pleasanton BART Station to Greenville Rd in the I-580 median
22668	San Mateo Co-wide	N	Add NB and SB I-680 HOV lns between Rte 84 in Alameda Co to Alcosta Blvd in Contra Costa Co
22670	San Mateo Co-wide	N	Widen I-880 for HOV lns NB from Hacienda overcrossing to 98th Ave and SB from 98th Ave to Marina Blvd
22671	San Mateo Co-wide	N	Construct direct HOV connection between SB I-880 to WB Rte 84
22700	Eastshore-North	V	Construct parallel corridor north of I-80 from Red Top Rd to Abernathy Rd
22701	Eastshore-North	V	I-80/I-680/Rte 12 I/C improvements
22702	Eastshore-North	V	I-80/I-680/Rte 12 I/C improvements: truck scales and aux lns (Phases 3 and 4)
22717	Eastshore-North	C	I-80/I-680/I-780 corridor improvements
22720	Peninsula	N	Caltrain grade separation program (San Mateo Co)
22722	Santa Clara Co-wide	C	Caltrain grade separation program in San Mateo Co
22723	Santa Clara Co-wide	C	Improvement of Dumbarton Bridge access to US 101 (Phase 2)
22724	Santa Clara Co-wide	V	Improve Rte 92 from San Mateo Bridge to I-280 (Phase 2)
22725	Santa Clara Co-wide	V	I-280/Rte 1 I/C improvements
22727	Santa Clara Co-wide	V	US 101/Peninsula Ave SB ramps
22729	Santa Clara Co-wide	V	I-280 aux lns from I-380 to Hickey Blvd
22739	Santa Clara Co-wide	C	US 101 operational improvements near Rte 92
22741	Santa Clara Co-wide	N	Caltrain express tracks (Phase 2) (San Mateo Co share)
22746	Santa Clara Co-wide	N	Widen Rte 29/First St overcrossing to 4 lns
22747	Santa Clara Co-wide	N	Rte 12/Rte 29/Rte 121 intersection improvements

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22751	Silicon Valley	V	Rte 1 operational and safety improvements in Half Moon Bay area
22756	Silicon Valley	V	US 101/Candlestick I/C reconstruction (Phase 1)
22761	Silicon Valley	V	I-880 from Hegenberger Rd to I-980 operation improvements
22763	Silicon Valley	V	Reconstruct SB I-880 on- and off- ramps and I-880/5th St seismic retrofit
22764	Silicon Valley	V	Construct aux ln on I-880 between Hegenberger Rd and 66th Ave and shift merge point of the WB Hegenberger Rd to I-880 on-ramp
22776	Silicon Valley	V	Widen Rte 84 to 4 lns from north of Pigeon Pass to Vineyard Ave and to 4 or 6 lns from Vineyard Ave to Jack London Blvd
22777	Silicon Valley	V	I-580 on- and off-ramp improvements in Castro Valley
22779	Silicon Valley	V	Rte 262/Warren Ave/I-880 I/C improvements (Phase 2)
22785	Silicon Valley	V	Construct I-580 EB aux ln from First St to Vasco Rd
22787	Silicon Valley	V	Realign Isabel/Vallecitos intersection for through movement on Rte 84
22796	Silicon Valley	V	Construct 4-ln arterial connection between future eastern end of Dublin Blvd in Dublin to North Canyons Parkway in Livermore
22800	Silicon Valley	V	BART extension into Santa Clara Co (needs operating plan)
22805	Silicon Valley	V	Widen Dixon Landing Rd to 6 lns between North Milpitas Blvd and 1-880
22806	Silicon Valley	V	Capitol Ave/Great Mall Pwy grade separation over Montague Expressway
22808	Silicon Valley	V	Caltrain grade separation program in Santa Clara Co
22814	Silicon Valley	V	Extend Foothill Expressway WB deceleration ln at San Antonio Rd
22823	Silicon Valley	V	Widen Snell Ave from 4 lns to 6 lns from Branham Ln to Chynoweth Ave
22830	Silicon Valley	V	Widen First St/Rte 152 to add one EB ln from Church St to Monterey St
22832	Silicon Valley	V	Widen Rte 152 from 2 lns to 4 lns from Miller Slough to Holsclaw Rd
22834	Silicon Valley	V	Widen Rte 237 for EB aux ln from Mathilda Ave to Fair Oaks Ave
22839	Silicon Valley	V	Convert HOV ln to mixed-flow ln on Central Expressway between San Tomas and De La Cruz
22843	Silicon Valley	V	Widen Lawrence Expwy /b/ Moorpark/Bollinger and south of Calvert to 8 lns
22845	Silicon Valley	V	Construct US 101 SB aux ln from Ellis St to EB Rte 237
22848	Silicon Valley	C	Develop HOT ln demonstration project on fwy corridor in Santa Clara Co
22850	Silicon Valley	C	Widen Almaden Plaza Way for a fifth ln at the approach of the Rte 85/Almaden Plaza Shopping Center/Alameda Expressway intersection
22857	Silicon Valley	C	Widen US 101 for a SB aux ln from I-880 to McKee Rd/Julian St
22858	Silicon Valley	C	Widen Union Ave from Los Gatos-Almaden Rd to Ross Creek to 4 lns
22871	Silicon Valley	C	Extend 2-ln Uvas Park Dr from Laurel Dr to Wren Ave
22872	Silicon Valley	C	Widen Montague Expressway for HOV lns between I-880 and I-680
22876	Silicon Valley	C	Convert HOV lns to mixed flow lns on Lawerence Expressway from US 101 to Elko
22878	Silicon Valley	C	Realign Wildwood Ave to connect with Lawrence Expressway
22881	Silicon Valley	C	Construct aux ln on SB Lawrence Expressway between WB Rte 237 and SB Lawrence Expressway
22888	Silicon Valley	C	Widen King Rd to 4 lns from Aborn Rd and Barberry Ln

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
22892	Silicon Valley	N	Widen US 101 SB aux ln from Great America Pwy to Lawrence Expwy
22893	Silicon Valley	N	Widen US 101 for a NB aux ln from McKee/Julian St to I-880
22897	Silicon Valley	N	Widen I-680 NB for an HOV ln from Rte 84 to Calavaras Blvd
22898	Silicon Valley	N	Widen I-80 from west of Meridian Rd to west of Kidwell Rd to 8 lns
22899	Silicon Valley	N	Widen Rte 12 between Suisun City and Rio Vista to 4 lns
22902	Silicon Valley	N	Future rail corridors to be determined by Major Investment Studies (MIS)
22911	Silicon Valley	N	Widen Farrell Ave Bridge to 2-ln facility
22925	Silicon Valley	N	DeWitt Ave S-curve realignment
22945	Silicon Valley	N	Construct Aldercroft Creek Bridge on Old Santa Cruz Highway
22958	Silicon Valley	N	US 101 SB to EB Rte 237 connector improvements
22965	Silicon Valley	N	US 101/Mabury Rd/Taylor St I/C construction
22981	Silicon Valley	N	Widen Rte 4 as 4-ln arterial from Marsh Creek Rd to San Joaquin Co line
22983	Silicon Valley	N	US 101/Zanker Rd/Skyport Dr/Fourth St I/C construction (Phase 2)
22986	Silicon Valley	N	Widen and improve BRdway between Rte 37 and Mini Dr from 2 lns to 4 lns
22988	Silicon Valley	N	Commuter Rail Service - Sacramento to Oakland (capital and operating)
22990	Silicon Valley	N	Widen Rte 262 from I-880 to Warm Springs Blvd
22991	Silicon Valley	N	Widen I-680 for SB HOV/HOT ln from Rte 237 to Rte 84
94024	Silicon Valley	N	Auto/truck separation ln at I-580/I-205 I/C
94030	Silicon Valley	N	Reconstruct I-880/Rte 262 I/C and widen I-880 from Rte 262 (Mission Blvd) to the Santa Clara Co to 10 lns (8 mixed-flow and 2 HOV lns)
94047	Silicon Valley	N	Extend the northern limits of the I-80 WB HOV ln from north of Cummings Skyway to Rte 4
94050	Silicon Valley	N	Upgrade Rte 4 to full fwy from I-80 to Cummings Skyway (Phase 2)
94051	Silicon Valley	N	I-680 aux ln from Diablo Rd to Sycamore Valley Rd (Segment 1) in Danville; from Crow Canyon Rd to Bollinger Canyon Rd (Segment 3) in San Ramon
94052	Silicon Valley	N	I-680 HOV lns from Marina Vista I/C to North Main St (SB) and from Rte 242 NB to the Marina Vista I/C
94071	Silicon Valley	N	Replace Napa River (Maxwell) Bridge and widen to 4 lns on Rte 121
94073	Silicon Valley	N	Construct new SB Rte 221 to SB Rte 29 flyover
94074	Silicon Valley	N	Widen Rte 12 from I-80 in Solano Co to Rte 29 in Napa Co to 4 lns
94075	Silicon Valley	N	Rte 12/Rte 29/Airport I/C construction
94089	Silicon Valley	N	Reconstruct Doyle Dr from Golden Gate Bridge toll plaza to Broderik St
94100	Silicon Valley	N	US 101 aux lns from Marsh Rd to Rte 92 (under construction)
94150	Silicon Valley	N	I-80/I-680/Rte 12 I/C improvements; includes connectors and aux lns between Green Valley Rd and Cordelia truck weigh station (Phase 1)
94151	Sunol Gateway	C	Construct 4-ln Jepson Parkway from Rte 12 to Leisure Town Rd
94152	Sunol Gateway	N	Widen Rte 12 from I-80 in Solano Co to Rte 29 in Napa Co to 4 lns
94165	Eastshore-North	V	US 101 NB and SB HOV lns from Rte 12 to Steele Ln in Santa Rosa
94504	Eastshore-North	V	Construct 4-ln Airport from I-880/98th Ave I/C to Oakland International Airport and then to Bay Farm Island

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
94506	Eastshore-North	V	Widen Rte 84 to 6-ln parkway from I-880 to Paseo Padre and 4-ln parkway from Paseo Padre to Mission Blvd along the Historic Parkway alignment
94514	Eastshore-North	V	I-880/Rte 92 I/C improvements
94531	Eastshore-North	C	Widen Rte 4 to 6 mixed flow lns and 2 HOV lns from Bailey Rd to Rail Rd Ave with median wide enough to accommodate future BART
94540	Eastshore-North	C	Carquinez Bridge replacement: construct new suspension bridge west of existing bridges and modify Crockett I/C
94541	Eastshore-North	C	New Benicia-Martinez Bridge: construct new bridge span east of existing span (4 mixed-flow lns and 1 slow-vehicle ln)
94563	Eastshore-North	C	Widen US 101 for HOV lns (one in each direction) from Lucky Dr in Corte Madera to North San Pedro Rd in San Rafael
94575	Eastshore-North	N	Construct grade-separated I/C at Rte 29 and Redwood Rd/Trancas St
94632	Eastshore-North	N	Third St Light Rail project: light rail transit ext to Bayview Hunters Point
94644	North Bay E-W	N	Rte 92 WB slow vehicle ln between Rte 35 and I-280
94656	North Bay E-W	N	Devil's Slide bypass
94675	Solano Co-wide	C	Widen Rte 37 from Napa River Bridge to Rte 29 to 4-ln fwy
96022	Solano Co-wide	N	Rte 4 Bypass, Segment 1: construct a 6-ln facility from Rte 4 to Laurel Rd and a 4-ln facility from Laurel Rd I/C to Lone Tree Way
98103	Golden Gate	V	Construct aux ln on NB Rte 17 from Camden Ave to Hamilton Ave
98104	Golden Gate	V	Widen Rte 4 from RailRd Ave to Loveridge: I/C impvts and hwy widening
98115	Golden Gate	V	Widen Ygnacio Valley/Kirker Pass Rds to 6 lns from MI Blvd to Cowell Rd
98119	Golden Gate	V	Vasona Corridor light rail extension from downtown San Jose to Winchester Blvd in Campbell
98121	Golden Gate	V	Increase Caltrain service from San Jose to Gilroy
98127	Golden Gate	V	I-680/Alcosta Blvd I/C improvements
98130	Golden Gate	V	Widen Alhambra Ave from Rte 4 to McAlvey Dr to 4 lns
98132	Golden Gate	V	Widen and extend Bollinger Canyon Rd to 6 lns from Alcosta Blvd to Dougherty Rd
98133	Golden Gate	V	Widen Pacheco Blvd from Blum Rd to Arthur Rd from 2 lns to 4 lns
98134	Golden Gate	V	Widen Dougherty Rd to 6 lns from Red Willow to Contra Costa Co line
98135	Golden Gate	V	Construct Windermere Parkway: 4 lns from Bollinger Canyon Rd extension to East Branch
98136	Golden Gate	V	Construct East Branch as 4 lns from Bollinger Canyon Rd extension to Camino Tassajara
98140	Golden Gate	V	I-680 Sunol Grade SB HOV lns and aux ln from Rte 84 to Rte 237
98142	Golden Gate	V	Widen Rte 4 to 8 lns with HOV lns from Loveridge Rd to Somersville Rd
98147	Golden Gate	V	Widen US 101 from Rte 116 east to the Marin/Sonoma Co line to 6 lns
98153	Golden Gate	V	Reconstruct MacArthur Blvd onramp for access to I-80 EB and I-580 WB
98154	Golden Gate	V	Widen US 101 from Rte 37 to the Sonoma Co line to 6 lns
98175	Golden Gate	V	Widen Montague Expressway to 8 lns from I-680 to US 101

Table 2.5-7: Transportation Projects with Potential Noise Impacts

Project ID	*Corridor*	*Investment**	*Description*
98176	Golden Gate	C	US 101 aux lns from 3rd Ave to Millbrae and US 101/Peninsula Ave I/C reconstruction
98178	Golden Gate	C	US 101/Sir Francis Drake Blvd improvements
98183	Golden Gate	C	Widen US 101 for HOV lns between Steele Ln and Windsor River Rd
98193	Golden Gate	C	Extend Panoramic Dr from North Concord BART Station to Willow Pass Rd
98194	Golden Gate	N	Extend Commerce Ave between Pine Creek and Waterworld Parkway to connect Willow Pass Rd with Rte 242/Concord Ave I/C
98196	Golden Gate	N	Rte 24 EB aux lns from Gateway Blvd to Brookwood Rd/Moraga Way
98198	North Bay E-W	V	Vasco Rd safety and operational impvts in Contra Costa and Alameda Co
98204	North Bay E-W	C	Construct Rte 1 NB and SB lns from Fassler Ave to Westport Dr in Pacifica
98207	North Bay E-W	C	I-880/BRdway-Jackson I/C improvements (Phase 1)
98211	Sonoma Co-wide	C	I-80 EB HOV ln ext from Rte 4 to the Crockett I/C S of Carquinez Bridge
98221	Sonoma Co-wide	V	Rte 4 Bypass, Segment 2, Phase2: widen to 4 lns from Lone Tree Way to Balfour Rd
98222	Sonoma Co-wide	V	Rte 4 Bypass, Segment 1: Rte 160 fwy-to-fwy connectors
98999	Sonoma Co-wide	N	Widen Rte 4 EB from 4 lns to 8 lns from Somersville Rd to Rte 160

**C=Committed, N=New Commitment, V=Vision Element*

2.6 Geology and Seismicity

This chapter analyzes the potential effects of the Bay Area geology and seismicity on the transportation improvements in the proposed Transportation 2030 Plan. It generally indicates potential difficulties and hazards, such as underlying geologic materials or proximity to faults, and provides mitigation measures that may reduce those difficulties and hazards to a less-than-significant level.

ENVIRONMENTAL SETTING

PHYSICAL SETTING

The physical setting describes existing geology in the study area, soils, faults, and other seismic and geologic hazards.

Geology

California is divided into 11 natural regions, referred to as geomorphic provinces, based on similar physical characteristics such as relief, landforms, and geology. The Bay Area is located primarily within the Coast Range geomorphic province, with portions of Contra Costa and Solano Counties extending into the Great Valley geomorphic province.

Coast Range

The Coast Range geomorphic province extends 400 miles along the Pacific Coast, from Oregon south into Southern California. Independent and discontinuous northwest-trending mountain ranges, ridges, and intervening valleys are distinguishing features of the Coast Range geomorphic province and generally characterize the geologic setting of the San Francisco Bay region. San Francisco Bay, which was formed within a shallow, regional structural depression, is the predominant feature, separating smaller northern and southern mountain ranges. In the southern Bay Area, the Santa Cruz Mountains border San Francisco Bay on the west, while the Berkeley Hills, an extension of the Diablo Range, are to the east. Mount Diablo marks the northern end of the Diablo Range, which stretches 130 miles southward to the Kettlemen Hills at the cusp of the San Joaquin Valley. The broad, low-relief Santa Clara and San Benito Valleys lie between the Santa Cruz Mountains and the Diablo Range. In the North Bay, the rugged, mountainous character of the Marin Peninsula is dominated by Mount Tamalpais (elevation 2,604 feet above sea level).

Much of the Coast Range province is composed of marine sedimentary and volcanic rocks that form the Franciscan Assemblage, located east of the San Andreas fault. The Franciscan Assemblage in this region of California is Jurassic- to Cretaceous-age (approximately 65 to 150 million years old) and consists primarily of greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments. The region west of the San Andreas fault is underlain by a mass of basement rock known as the

"Salinian Block." This block contains igneous rocks,[1] Tertiary-age (up to 65 million years old) marine sandstone, and various metamorphic rocks[2] believed to have originated some 350 miles to the south. The Salinian Block has been moving northward along the west side of the San Andreas fault and associated rocks can be found as far north as Point Arena.

Marginal lands surrounding San Francisco Bay are generally alluvial plains of low relief that slope gently bayward from the bordering uplands and foothills. The alluvial plains that comprise the Bay margin are composed of Quaternary-age (up to 2 million years old) alluvial sediments consisting of unconsolidated stream and basin deposits. These alluvial plains terminate bayward at the tidal marshlands that surround the Bay. Marshlands are composed of intertidal deposits, including the fine-grained plastic clay known as "Bay Mud," which, in some areas, underlies artificial fills. San Francisco Bay is originally believed to have encompassed 700 square miles, although dredging and fill operations have reduced the Bay to approximately 400 square miles. Historic shoreline reclamation resulted in the placement of varying types of man-made artificial fill that overlie intertidal deposits.

Great Valley

Portions of Solano and Contra Costa Counties are located in the Great Valley geomorphic province, which consists of a large, nearly level inland alluvial plain 400 miles in length and averaging 50 miles in width. The topography of the Great Valley is flat, but slopes gently along its eastern margin (Sierra Nevada foothills) and western margin (Coast Ranges). Sediments in the Great Valley are gravels, sands, clays, and silts that originated largely from the Sierras, with sediments from the Coast Range contributing to a lesser extent. The sediments that compose the valley floor are thick, and in some areas extend as far as 10 miles below the surface. The Great Valley Sequence, a thick section of ancient sea floor sediments extending under the Great Valley, overlies the Coast Range Franciscan Assemblage along the valley's western flank.

Soils

A wide variety of soils form the alluvial plains bordering San Francisco Bay. Soils in the Bay Area fall within four major classifications established by the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). Depending on localized conditions, these general classifications are grouped into more specific soil types by location, climate, and slope. The Santa Clara valley and the alluvial plains surrounding San Francisco Bay are classified as deep alluvial plain and floodplain soils. These soils occupy the valleys in areas with higher rainfall and are considered productive when drained and fertilized. Soils closer to the Bay margin are generally dark-colored clays that have a high water table or are subject to overflow from flooding. Throughout California, Bay margin soils are typically used for wheat, barley, and native pastureland. Soils at the extreme edge of San Francisco Bay have a moderate to high content of

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[1] Igneous rocks are those that form from molten magma, such as granite.

[2] Metamorphic rocks are sedimentary or volcanic rocks altered by prolonged heating and deformation.

soluble salts; these soils are referred to as “alkali soils” and can be used for salt grass pasture or for production of salt-tolerant crops. Soils in northern San Mateo County, the eastern portion of the city of San Francisco, and in Marin County are classified as residual soils and are characterized by moderate depth to underlying bedrock. Residual soils are present in natural grasslands where annual rainfall is considered moderately high; these grasslands constitute some of the best natural grazing lands in California.[3]

Seismicity

The San Francisco Bay Area contains both active and potentially active faults and is considered a region of high seismic activity.[4] The 1997 Uniform Building Code (UBC), published by the International Conference of Building Officials, locates the entire Bay Area within Seismic Risk Zone 4. Areas within Zone 4 are expected to experience maximum ground shaking severity and damage in the event of an earthquake.[5] The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area, and concluded that there is currently a 62 percent likelihood of a magnitude 6.7 or higher earthquake occurring in the Bay Area by 2032.[6]

The San Andreas and the Hayward faults are the two principally active, strike-slip-type faults[7] in the Bay Area and have experienced movement within the last 150 years. The San Andreas fault is a major structural feature in the region and forms a boundary between the North American and Pacific tectonic plates. Other principal faults capable of producing significant Bay Area ground shaking are listed in Table 2.6-1 and include the Calaveras fault, the Rodgers Creek fault, and the Concord–Green Valley faults, as shown on Figure 2.6-1. A major seismic event on any of these active faults could cause significant ground shaking and surface fault rupture, as was experienced during earthquakes in recent history, namely the 1868 Hayward earthquake, the 1906 San

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[3] Division of Agricultural Science, University of California, Generalized Soil Map of California, 1951.

[4] An active fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A potentially active fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not mean that faults lacking evidence of surface displacement are necessarily inactive. “Sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, E. W., Fault-Rupture Hazard Zones in California: Alquist-Priolo Special Studies Zones Act of 1972 with Index to Special Studies Zones Maps, California Division of Mines and Geology, Special Publication 42, 1990, revised 1997).

[5] Lindeburg, M., Seismic Design of Building Structures: A Professional’s Introduction to Earthquake Forces and Design Details, Professional Publications Inc., 1998.

[6] U.S. Geological Society (USGS) Working Group on California Earthquake Probabilities (WG02), Earthquake Probabilities in the San Francisco Bay Region: 2003-2032 – A Summary of Findings, Open-File Report 03-214, 2003.

[7] “Strike-slip” faults primarily exhibit displacement in a horizontal direction, but may have a vertical component. Right-lateral strike-slip movement of the San Andreas fault, for example, means that the western portion of the fault is slowly moving north while relative motion of the eastern side is to the south.

Francisco earthquake, and the 1989 Loma Prieta earthquake. The estimated magnitudes (moment) identified in Table 2.6-1 represent *characteristic* earthquakes on particular faults.[8]

Table 2.6-1: Active Faults In The MTC Study Area

Fault	*Recency of Movement*	*Historical Seismicity*[2]	*Maximum Moment Magnitude Earthquake (Mw)*[3]
Hayward	1868 Holocene	M6.8, 1868 Many <M4.5	7.1
San Andreas	1989 Holocene	M7.1, 1989 M8.25, 1906 M7.0, 1838 Many <M6	7.9
Rodgers Creek	1969 Holocene	M6.7, 1898 M5.6, 5.7, 1969	7.0
Concord–Green Valley	1955 Holocene	Historic active creep	6.9
Marsh Creek-Greenville	1980 Holocene	M5.6 1980	6.9
San Gregorio–Hosgri	Holocene; Late Quaternary	Many M3-6.4	7.3
West Napa	2000 Holocene	M5.2 2000	6.5
Maacama	Holocene	Historic active creep	7.1
Calaveras	1990 Holocene	M5.6-M6.4, 1861 M4 to M4.5 swarms 1970, 1990	6.8

1 See text footnote #4 for definition of active faults.

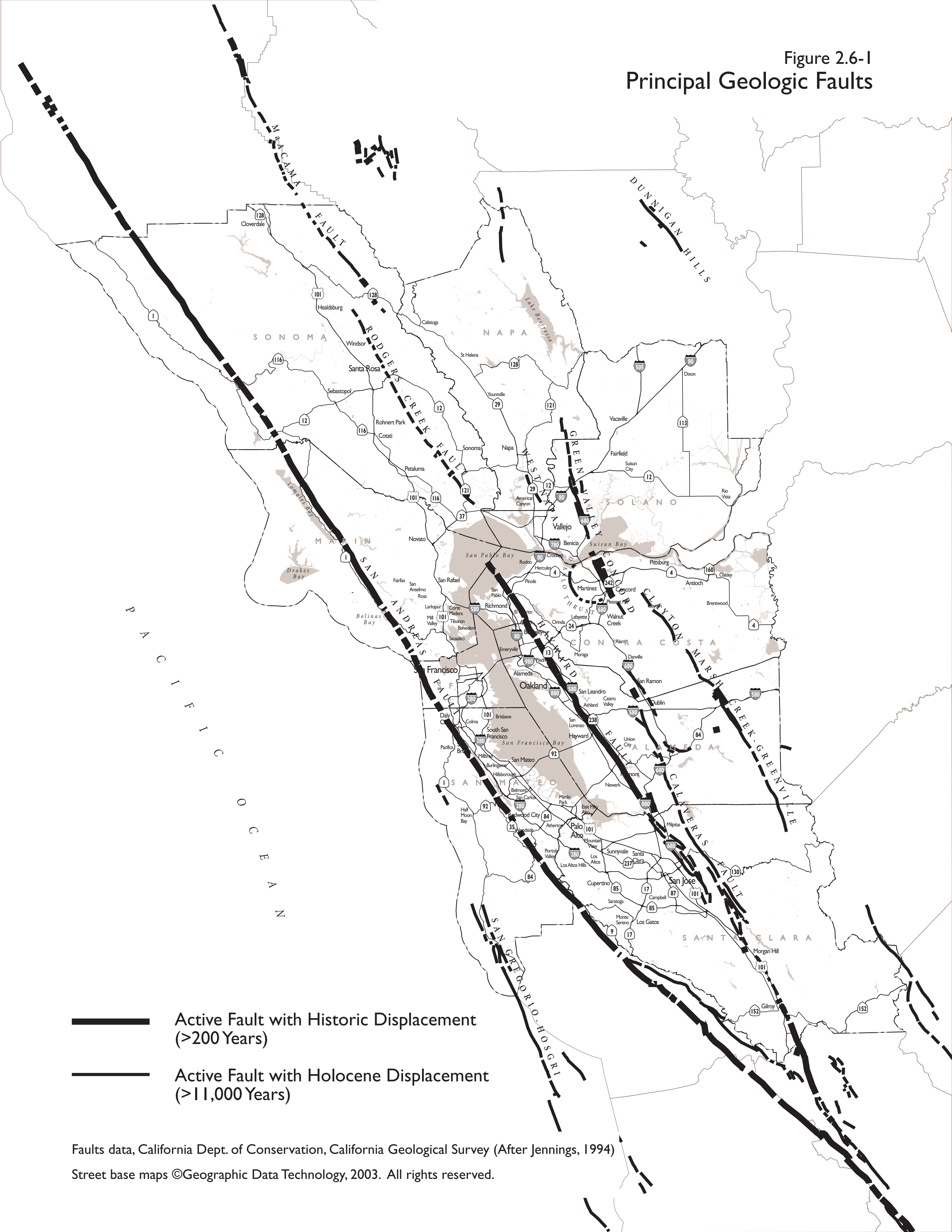
2 Richter magnitude (M) and year for recent and/or large events. Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave.

3 The maximum moment magnitude earthquake (Mw), derived from the joint CGS/USGS Probabilistic Seismic Hazard Assessment for the State of California, 1996. (CGS OFR 96-08 and USGS OFR 96-706).

Sources: CGS, 1996, Hart, 1997; Jennings, 1997; Peterson, 1996; United States Geological Survey and University of California Berkeley, Northern California Earthquake Data Center, http://quake.geo.berkeley.edu/, accessed May 2004

8 Moment magnitude is related to the physical size of a fault rupture and movement across a fault, while Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event. The concept of “characteristic” earthquake means that we can anticipate, with reasonable certainty, the actual damaging earthquakes [the size of the earthquakes] that can occur on a fault.

Figure 2.6-1
Principal Geologic Faults



Active Fault with Historic Displacement (>200 Years)

Active Fault with Holocene Displacement (>11,000 Years)

Faults data, California Dept. of Conservation, California Geological Survey (After Jennings, 1994)

Street base maps ©Geographic Data Technology, 2003. All rights reserved.

Geologic and Seismic Hazards

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude and nature of fault rupture can vary for different faults or even along different strands of the same fault. Future faulting is generally expected along different segments of faults with recent activity.[9] Structures, transportation facilities, and utility systems crossing fault traces are at risk during a major earthquake due to ground rupture caused by differential lateral and vertical movement on opposite sides of the active fault trace. Lateral displacement may range from a few inches to over 20 feet, as occurred in the 1906 San Francisco earthquake. Thrust faults as well as faults with strike-slip movement can have a vertical displacement component that can total several feet.

However, the exception to obvious surface displacement is the "blind-thrust" fault. The Mt. Diablo blind-thrust fault, for example, is a newly recognized earthquake source for the San Francisco Bay Region. It has been mapped on the western base of Mt. Diablo on the east side of the San Ramon Valley. The USGS Working Group on California Earthquake Probabilities recommended that this particular thrust fault be considered in their seismic probability calculations. This fault is considered a "blind thrust" because it does not exhibit a surficial expression of displacement. The Mt. Diablo thrust fault slips at a long term rate of about 3 millimeters/year, but has not been zoned as an active fault under the Alquist-Priolo Act (see description of Act in Regulatory Setting).[10]

Although multiple active and potentially active faults are located within the Bay Area, ground rupture is most likely to occur along active faults zoned as Earthquake Fault Zones under mandate of the Alquist-Priolo Act. It is important to note that surface fault rupture is not necessarily restricted to the area within an Alquist-Priolo Zone. Additionally, ground rupture is possible on both active and potentially active faults not zoned as Earthquake Fault Zones, although these faults are considered less susceptible to ground rupture hazards than the principally active faults listed in Table 2.6-1.

Ground Shaking

Strong ground movement from a major earthquake could affect the Bay Area during the next 30 years. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter. The intensity of ground movement during an earthquake can vary depending on the overall magnitude, distance from the fault, focus of earthquake energy, and type of geologic material.

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[9] California Geological Survey, Guidelines for Evaluating and Mitigation Seismic Hazards, CGS Special Publication 117, 1997.

[10] USGS, 2003.

Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill. The composition of underlying materials in areas located relatively distant from faults can intensify ground shaking. For example, portions of the Bay Area that experienced the worst structural damage due to the Loma Prieta earthquake were not those closest to the fault, but rather those with soils that amplified the effects of ground shaking. The Modified Mercalli (MM) intensity scale (see Table 2.6-2) is a common measure of earthquake effects due to ground shaking intensity. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.[11]

Areas most susceptible to intense ground shaking are those areas located closest to the earthquake-generating fault, and areas underlain by thick, loosely unconsolidated, saturated sediments, particularly soft, saturated Bay Muds and artificial fill along the tidal margins of San Francisco Bay.

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near saturated soils lose cohesion and are converted to a fluid state as a result of severe vibration. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, airport runways, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at shallow depths, or in saturated unconsolidated or artificial fill sediments located in reclaimed areas along the margin of San Francisco Bay. Liquefaction potential is highest in areas underlain by a shallow groundwater and Bay fills, Bay Mud, and unconsolidated alluvium. Figure 2.6-2 illustrates liquefaction susceptibility in the San Francisco Bay Area.

Landslide Hazards

A landslide is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. The susceptibility of land (slope) failure is dependent on slope and geologic characteristics, as well as the amount of rainfall and the nature of excavation or seismic activities. Areas with steep slopes and downslope creep of surface materials are most susceptible to landsliding.

Landslides are least likely in areas of low relief, such as topographically low alluvial fans and at the margin of San Francisco Bay. Figure 2.6-3 illustrates areas that have historically been affected by landslide activity.

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[11] The damage level represents the estimated overall level of damage that will occur for various MM intensity levels. The damage, however, will not be uniform. Some structures will experience substantially more damage than this overall level, and others will experience substantially less damage. Not all structures perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a structure all affect its performance (Association of Bay Area Governments (ABAG), *The San Francisco Bay Area -- On Shaky Ground*, Supplement Report (Excerpts), 1998.).

Table 2.6-2: Modified Mercalli Intensity Scale

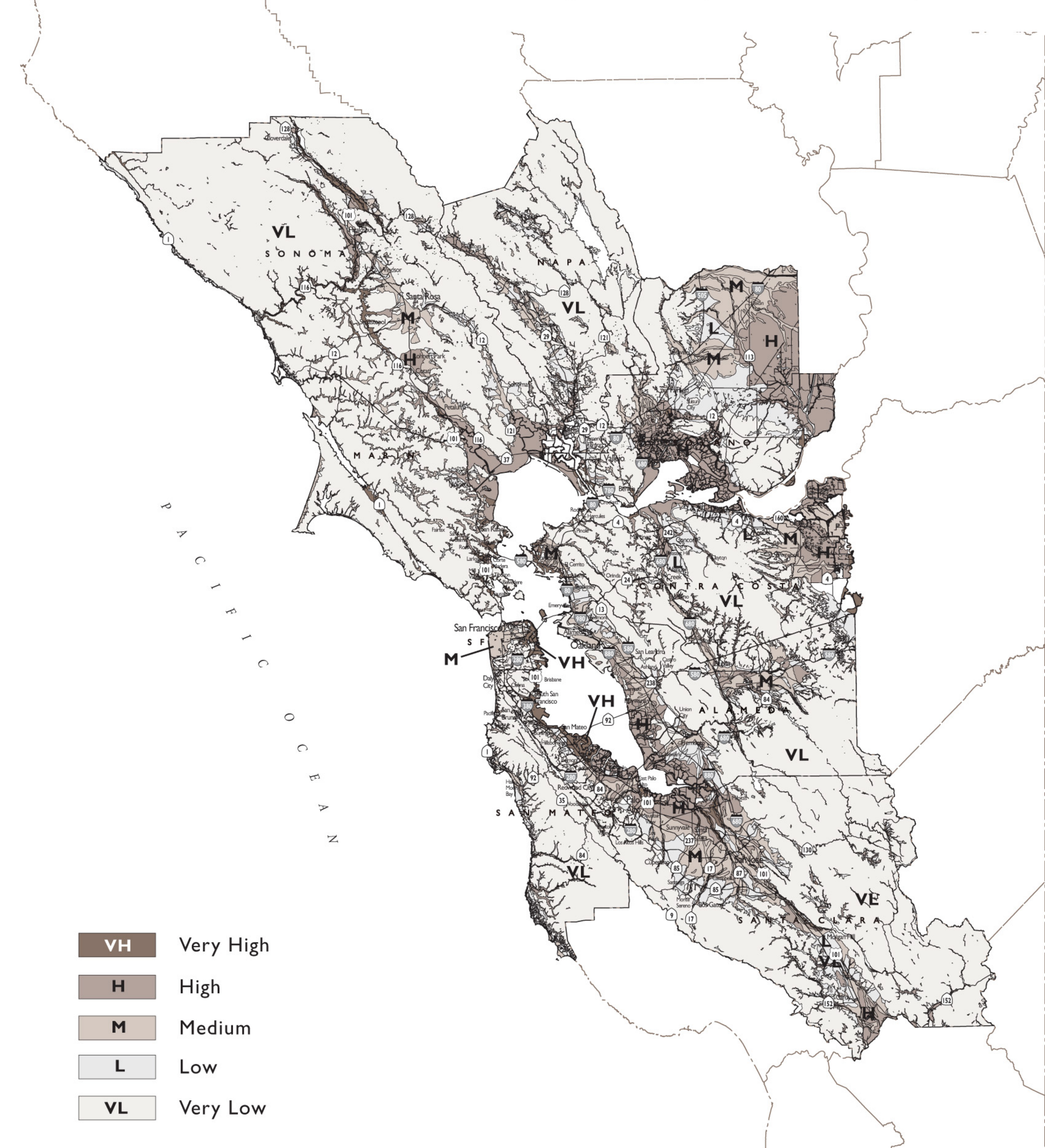
	Intensity Description	*Average Peak Acceleration*[1]
I	Not felt except by a very few persons under especially favorable circumstances.	<0.0017g
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	<0.014g
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many persons do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to a passing of a truck. Duration estimated.	<0.014g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014g-0.039g
V	Felt by nearly everyone, many awakened. Some dishes, windows, broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.	0.039g-0.092g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.	0.092g-0.18g
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18g-0.34g
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Persons driving motor cars disturbed.	0.34g-0.65g
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65g-1.24g
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes.	> 1.24g
XI	Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24g
XII	Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24g

[1] g (gravity)= 980 centimeters per second squared. Acceleration of 1.0 g is equivalent to a car traveling 328 feet from rest in 4.5 seconds.

Source: Bolt, 1988, and California Geological Survey, 2003

Figure 2.6-2

Areas Susceptable to Liquefaction in the Bay Area

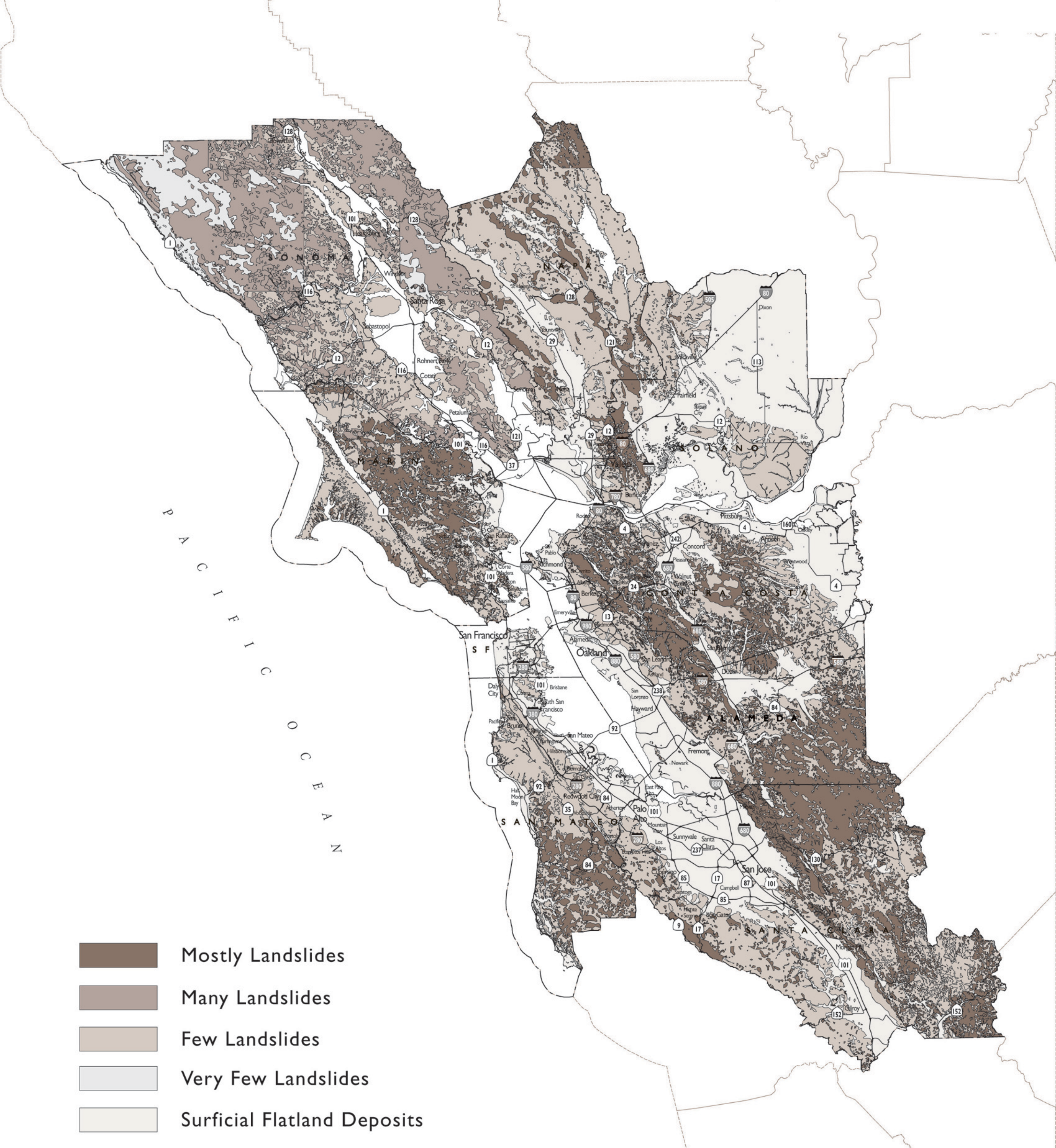


Liquefaction data, USGS, 2000.

Street base maps ©Geographic Data Technology, 2003. All rights reserved.

Figure 2.6-3

Areas Susceptable to Landslides



Landslides data, USGS, 1997.

Street base maps ©Geographic Data Technology, 2003. All rights reserved.

Expansive Soils

Expansive soils possess a "shrink-swell" characteristic. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur incrementally over a long period of time, usually as a result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. Soils with high clay content, such as the Bay Muds located on the southern margin of San Francisco Bay, are highly expansive.

Soil Erosion

Soil erosion is the process whereby soil materials are worn away and transported to another area, either by wind or water. Rates of erosion can vary depending on soil material and structure, building placement, and human activity. The potential for soil erosion is variable throughout the project area. Soil with high amounts of silt can be easily eroded, while sandy soils are less susceptible to erosion. Excessive soil erosion can eventually damage building foundations, roadways, and dam embankments. Erosion is most likely on sloped areas with exposed soil, especially where unnatural slopes are created by cut-and-fill activities. Soil erosion rates can therefore be higher during the construction phase. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, or asphalt.

Settlement

Settlement is the depression of the bearing soil when a load, such as that of a building or new fill material, is placed upon it. Soils tend to settle at different rates and by varying amounts, depending on the load weight, which is a phenomenon referred to as differential settlement. Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or the "Bay Mud" present in the marshland on the San Francisco Bay margin.

Earthquake-Induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid compaction and settling of subsurface materials (particularly loose, noncompacted, and variable sandy sediments) due to the rearrangement of soil particles during prolonged ground shaking. Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or Bay Mud.

Tsunamis

Tsunamis (seismic sea waves) are long period waves that are caused by underwater seismic disturbances, volcanic eruptions, or submerged landslides. Tsunamis affecting the Bay Area would most likely originate west of the Bay, within the Pacific Rim. During the period between 1854 and 1964, approximately 21 tsunamis were recorded at the Fort Point tide gauge in San

Francisco. The largest wave height recorded was 7.4 feet resulting from the 1964 Alaska earthquake. It is estimated that a tsunami with a wave height or run up to 20 feet could pass through the Golden Gate every 200 years. A ten-foot wave is estimated to occur every 90 years. A tsunami of this height would most likely produce little inundation damage except for beaches and other low-lying coastal areas.

Areas that are highly susceptible to tsunami inundation tend to be located in low-lying coastal areas such as tidal flats, marshlands, and former bay margins that have been artificially filled. Highway traffic in those low-lying areas may be disrupted due to inundation or damage caused by the tsunami.

REGULATORY SETTING

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law in December 1972, requires the delineation of zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones, for example, by withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement.[12] Surface fault rupture is not necessarily restricted to the area within an Alquist-Priolo Zone.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 was established to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. Although Seismic Hazards Maps have been released for San Francisco County and portions of the East and South Bay, the California Geological Survey has not yet completed Seismic Hazards Maps covering the entire Bay Area.

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[12] Hart, 1997.

California Department of Transportation

Jurisdiction of the California Department of Transportation (Caltrans) includes state and interstate routes within California. Any work within the right-of-way of a federal or state transportation corridor is subject to Caltrans regulations governing allowable actions and modifications to the right-of-way. Caltrans issues permits to allow encroachment on land within its jurisdiction to ensure that the encroachment is compatible with the primary uses of the State Highway System, ensure safety, and to protect the state's investment in the highway facility. The encroachment permit requirement applies to persons, corporations, cities, counties, utilities, and other government agencies. A permit is required for specific activities, including opening or excavating a state highway for any purpose, constructing and maintaining road approaches or connections, grading within right-of-way on any state highway, or planting or tampering with vegetation growing along any state highway. The encroachment permit application requirements relating to geology, seismicity, and soils include information on road cuts, size of excavations, engineering and grading cross-sections, hydraulic calculations, and the location of mineral resources approved under the Surface Mining Area Reclamation Act.

County and City Controls

City and county governments develop, as part of a general plan, safety and seismic elements that identify goals, objectives, and implementing actions to minimize the loss of life, property damage, and disruption of goods and services from disasters, including floods, fires, nonseismic geologic hazards, and earthquakes. General plans can provide policies and establish the basis for ordinances to ensure acceptable protection of people and structures from risks associated with these hazards. Ordinances can include those addressing unreinforced masonry construction, erosion, or grading

IMPACT ANALYSIS

SIGNIFICANCE CRITERIA

This EIR uses the following geology and seismicity criteria to assess whether improvements in the proposed Transportation 2030 Plan would have a significant adverse effect.

- **Criterion 1: Expose people or structures to potential damaging geologic forces.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects increase exposure of people or structures to the risk of property loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault
  - Strong seismic ground shaking
  - Seismic-related ground failure, including liquefaction
  - Landslides

- **Criterion 2: Substantial soil erosion or topsoil loss.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects result in substantial soil erosion or topsoil loss.

- **Criterion 3: Located on expansive soils.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects are located on expansive soils (high shrink-swell potential), as defined in Table 18-1-B of the Uniform Building Code, or on weak, unconsolidated soils creating substantial risks to life or property.

METHOD OF ANALYSIS

Impacts are determined for the proposed Transportation 2030 Plan as a whole and for specific projects involving new construction. Projects which do not include the construction of infrastructure, such as new bus line schedules or routes, local road maintenance, wheelchair curb ramps, or traffic light coordination would utilize existing transportation infrastructure or would result in negligible alterations to these facilities. In contrast, other projects in the proposed Transportation 2030 Plan would include the construction or expansion of elevated interchanges, roadways, bridges, tunnels, transit buildings, and parking lots. Some of these projects may be susceptible to particular seismic hazards such as strong ground shaking due to their location near active faults. The analysis is based upon generalized geology maps which provide broad information on the locations of active faults in the San Francisco Bay Area and areas of liquefaction or landslide potential. Due to the scale of these maps, this analysis provides a summary of generalized potential impacts associated with seismic hazards present in the San Francisco Bay Area and does not satisfy the need for site-specific surveys for individual projects.

SUMMARY OF IMPACTS

The entire Bay Area is susceptible to impacts associated with seismic events on one of the several active or potentially active faults in the region. These faults could potentially generate seismic ground shaking capable of damaging existing and proposed transportation facilities. As such, new transportation facilities would be exposed to both the direct and indirect effects of earthquakes. Potential effects from surface fault rupture and severe ground shaking could cause catastrophic damage to transportation infrastructure, particularly elevated structures. Geologic hazard exposure during construction would be considered short-term, while long term risk of hazards and seismic impacts would be expected to continue throughout the life of the project or facility. The proposed Transportation 2030 Plan includes the vast majority of the seismic retrofit and strengthening work for Bay Area transportation facilities, particularly the Bay Bridge. New transportation facility designs would make use of the latest information available on seismic hazards to structures.

Direct Impacts

Direct impacts associated with earthquakes include construction of new transportation facilities which would be exposed to fault rupture, ground shaking, liquefaction and potential tsunamis, and earthquake-induced landslides. Over time, unconsolidated soils can also pose problems to transportation facilities.

Short Term Impacts

Short-term impacts are those that could potentially occur during construction of transportation improvements. Soil erosion hazards could occur during preliminary stages of construction, especially during initial site grading. In addition to causing sedimentation problems in storm drain systems, rapid water erosion could remove topsoil, cause deeply incised gullies on slopes, or undermine engineered soils beneath foundations and paved surfaces.

Long Term Impacts

Geologic hazards present long term risks to the transportation network, despite current engineering technology. Seismic hazards, such as surface fault rupture, ground-shaking, earthquake-induced landslides, liquefaction, and tsunamis, are considered significant and unavoidable, given California's seismicity. Erosion and soil hazards (i.e., differential settlement, expansive soils, and landslides) are considered significant, but mitigable potential impacts.

Indirect / Cumulative Impacts

The projected population increase in the Bay Area will result in increased travel and associated increased risk of exposure of people and property to the risks of strong seismic shaking, fault rupture, seismically-induced ground failure and slope instability on both existing and proposed transportation infrastructure.

Beneficial Impacts

The proposed Transportation 2030 Plan includes seismic strengthening of a number of existing bridges, interchanges, and overpasses throughout the Bay Area. In addition, all new transportation facilities, including potentially vulnerable elevated structures such as BART tracks, interchanges, and bridges, will be designed to current seismic standards that were updated as a result of information acquired from the Loma Prieta and Northridge earthquakes. It is expected that as a result of these efforts, implementation of the Transportation 2030 Plan will improve the survivability of the Bay Area transportation system, reduce the risk to travelers using existing retrofitted and new transportation facilities, and reduce the overall magnitude and extent of social and economic disruption in the event of a major seismic event.

IMPACTS & MITIGATION MEASURES

Impact

2.6-1 Seismic events could damage existing and proposed transportation infrastructure through surface rupture, ground shaking, liquefaction, landslides and tsunamis *(Significant, unavoidable).*

Some of the proposed transportation improvement projects would be located within Alquist-Priolo Earthquake Fault Zones and would therefore be susceptible to fault rupture if an earthquake were to occur on the particular fault segment. The occurrence and severity of fault rupture depends on, among other factors, the location of the fault trace, magnitude of the seismic event, and underlying geology. Damage caused by surface fault rupture could include displaced pavement, rupture to underground utilities, or damage to foundations.

Table 2.6-3 (at the end of this chapter) provides examples of projects susceptible to surface fault rupture hazards. Projects susceptible to severe fault rupture are generally those very close to one of the 11 major active earthquake-generating faults depicted on Figure 2.6-1. Potential for structural damage injury or of life is related to the severity of the earthquake or type of construction (aerial, at-grade, tunnels, etc.). Modern design techniques focus on the preservation of life and lessening the risk of injury. These are projects with the potential to be adversely affected by lateral or vertical displacement during an earthquake of considerable magnitude.

Ground Shaking. Proposed transportation improvements susceptible to intense seismic ground shaking are also those areas in close proximity to the causative faults, and those areas underlain by thick, unconsolidated deposits, particularly soft, saturated Bay Mud and artificial fill near the shoreline of the Bay. These soft, loosely consolidated, saturated sediments have the tendency to amplify ground shaking and cause structural damage or result in collapse of older structures, especially those that have not undergone seismic retrofitting.

Liquefaction and Earthquake-Induced Landslides. The California Geological Survey, pursuant to the Seismic Hazards Act of 1990, has begun preparing seismic hazard maps of the San Francisco Bay Area. These maps identify areas highly susceptible to liquefaction or earthquake-induced landslides. At this time, only a portion of the Bay Area has been mapped. Therefore, earlier mapping completed by the United States Geological Survey is utilized in order to uniformly assess areas prone to liquefaction or landslides for proposed transportation improvements in the Transportation 2030 Plan.

The potential for transportation projects to be significantly affected by earthquake-induced landslides is higher in hilly or mountainous areas, especially areas with historically active or inactive landslides and unstable slopes. Landslide hazards are prevalent in the Santa Cruz Mountains, the Diablo Range, and areas of Marin County. Certain geologic formations, such as loosely consolidated sedimentary deposits, are more susceptible to landslides in the event of an earthquake. Saturated slopes in close proximity to the causative fault can also increase the likelihood of landslide hazards. Landslide-prone areas are depicted in Figure 2.6-2, and project located within areas most likely to susceptible to landslides are listed in Table 2.6-3.

The potential for projects to be significantly affected by liquefaction is higher in areas underlain by shallow groundwater and unconsolidated, coarse-grained soils, such as sandy artificial fill materials or dredge spoils overlying Bay Mud. Areas historically affected by liquefaction are depicted in Figure 2.6-3, and projects located in areas likely to be susceptible to very high or high levels of liquefaction are listed in Table 2.6-3.

Tsunamis. Tsunamis could occur along the Pacific Ocean shoreline and along the Bay shoreline resulting in temporarily high water levels and possible property damage, erosion, injury and loss of life and structural damage.

Mitigation Measures

2.6(a) Project implementation agencies shall undertake project specific review of seismic impacts as part of project specific environmental review. For any identified impacts, appropriate mitigation measures shall be identified to minimize or eliminate any significant impacts on water resources. The following mitigation measures shall be included in project-level analysis as appropriate for proposed new transportation improvements. The project proponent or local jurisdiction shall be responsible for ensuring adherence to the mitigation measures outlined below prior to construction.

- The seismic design of projects shall consider seismicity of the site, soil response at the site, and dynamic characteristics of the structure, in compliance with the Uniform Building Code and Caltrans standards for construction, or other more stringent standards, as applicable.
- Implementing agencies shall ensure that geotechnical analyses are conducted within construction areas to ascertain soil types and local faulting prior to preparation of project designs.
- For projects location within Alquist-Priolo Earthquake Fault Zones, recommendations for the mitigation and reduction of hazards shall be prepared in accordance with California Geological Survey Guidelines for Evaluation the Hazard of Earthquake Fault Rupture.[13]
- Implementing agencies shall ensure that projects avoid or stabilize landslide areas and potentially unstable slopes wherever feasible.
- For projects located within liquefaction or earthquake-induced landslide Seismic Hazard Zones, recommendations for the mitigation and reduction of hazards shall be prepared in accordance with California Geological Survey Guidelines for Evaluating and Mitigating Seismic Hazards.[14]

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[13] CGS, 2002.
[14] CGS, 1997.

- Consider tsunami inundation risks when designing projects adjacent to the Bay, and/or Pacific Ocean. Precautionary measures such as specifying final roadbed elevations greater than the expected height of a tsunami with a given return frequency would be effective.

Implementation of the above mitigation measures would reduce seismic hazards from new transportation facilities. Although most new structures would be constructed to survive a strong earthquake without collapse, it is likely that some segments of roads and transit facilities would be damaged. The damage from a major seismic event could be significant.

Impact

2.6-2 Highway and rail construction, under the proposed Transportation 2030 Plan, could require significant earthwork and road cuts, which could increase short-term and long term soil erosion potential and slope failure. ***(Significant, mitigable)***

Road cuts could expose soils to erosion over the life of the project, creating potential landslide and falling rock hazards. Engineered roadways can be undercut over time by uncontrolled stormwater drainage. Projects on steep grades or those requiring substantial amounts of cut and fill would pose the greatest potential for slides and erosion impacts. Engineered soils could also erode due to poor construction methods and design features or lack of maintenance. Use of appropriate construction methods, earthwork design, and road cut design could reduce this potential impact to a less-than-significant level.

Mitigation Measures

2.6(b) Implementing agencies shall ensure that projects employ Best Management Practices to reduce soil erosion by water and wind. These could include temporary cover of exposed, engineered slopes, or silt fencing. All construction activities and design criteria shall comply with applicable codes and requirements of the 1997 Uniform Building Code with California additions (Title 22), and applicable Caltrans construction and grading ordinances.

2.6(c) Implementing agencies shall ensure that project designs provide adequate slope drainage and appropriate landscaping to minimize the occurrence of slope instability and erosion. Design features shall include measures to reduce erosion from stormwater. Road cuts shall be designed to maximize the potential for revegetation.

These mitigation measures would be expected to reduce this potentially significant risk of soil erosion and/or slope failure to a less-than-significant level if incorporated by project sponsors.

Impact

2.6-3 Projects built on highly compressible or expansive soils could become damaged and weakened over time. ***(Significant, mitigable)***

Inadequate soil and foundation engineering on weak or unconsolidated soils (such as poorly engineered artificial fill) could cause soils and overlying structures to settle unevenly, thereby weakening structural facilities. Low-strength soils subjected to settlement could, over time, cause damage to underground utilities such as pipelines and tunnels. Structures placed directly on expansive soils could be subject to seasonal shrink/swell effects, causing structural damage and possibly damage to underground utilities.

Mitigation Measures

2.6(d) Implementing agencies shall ensure that geotechnical investigations be conducted by qualified professionals (registered civil and geotechnical engineers, registered engineering geologists) to identify the potential for differential settlement and expansive soils. Recommended corrective measures, such as structural reinforcement and replacing soil with engineered fill, shall be incorporated into project designs. These mitigation measures would be expected to reduce the risk of exposure to highly compressible or expansive soils to a less-than-significant level if incorporated by project sponsors.

Cumulative Impact

2.6-4 The projected population increase in the Bay Area will result in increased travel on all modes of transportation. This would result in an increased risk of exposure of people and property to the potentially damaging effects of strong seismic shaking, fault rupture, seismically-induced ground failure and slope instability. ***(Significant, mitigable)***

Cumulative population growth over the next 25 years would result in increased population using existing and proposed transportation infrastructure. The potential for structural failures, injuries and loss of life would be greatest on raised structures, on earthquake susceptible soils and within fault zones. However, this increase in risk is partially offset by safety and operational improvements and other transportation infrastructure improvements included in the Transportation 2030 Plan and described in the Summary of Impacts section (above). The cumulative impacts from the Transportation 2030 Plan are essentially the same as the direct impacts outlined above.

Mitigation Measures

Since the cumulative impacts from the Transportation 2030 Plan are essentially the same as the direct and short-term impacts (exposing travelers to geologic hazards), the mitigation measures for this impact would be the same as described in measure 2.6(a). These mitigation measures would be expected to reduce this potentially significant cumulative impact to a less-than significant level.

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
98203	Peninsula	N	Study Rte 1 in Half Moon Bay			X
21613	Peninsula	N	Rte 92 improvements from San Mateo Bridge to I-280		X	X
21619	Peninsula	N	Caltrain express tracks	X	X	X
22282	Peninsula	N	US-101 capacity imprvts near SR 92			X
94644	Peninsula	V	Rte 92 W slow vehicle lane		X	
21604	Peninsula	V	US 101 aux lanes from Sierra Pt to San Francisco County		X	X
21610	Peninsula	V	US 101 aux lanes from San Bruno Ave to Grand Ave			X
21892	Peninsula	V	Widen Rte 84			X
22227	Peninsula	V	Geneva Ave Extension: Bayshore Blvd to US 101			X
22228	Peninsula	V	Lagoon Way Extension			X
22229	Peninsula	V	Sierra Point Parkway/US 101interchange		X	
22271	Peninsula	V	Widen Skyline Blvd (Rte 35) from I-280 to Sneath Lane to 4-lanes	X		
22279	Peninsula	V	US 101/Produce Ave interchange project			X
22724	Peninsula	V	Rte 92imprvts: San Mateo Bridge to I-280		X	X
22751	Peninsula	V	Rte 1 in Half Moon Bay operational & safety improvements			X
22800	Peninsula	V	BART extension from Santa Clara Co			X
22655	Golden Gate	C	Widen US 101 for HOV lanes Rohnert Park Expressway to Santa Rosa Ave		X	X
98147	Golden Gate	N	Widen US 101 from Rte 116 E to Marin/Sonoma County to 6 lanes, upgrade Petaluma Bridge	X	X	X
98154	Golden Gate	N	Widen US 101 from Rte 37 to Sonoma County to 6 lanes	X	X	X
98183	Golden Gate	N	Widen US 101 for HOV lanes Steele Ln to Windsor River Rd	X	X	
21902	Golden Gate	N	Widen US 101 for HOV lanes from Old Redwood Hwy to Rohnert Park Expwy	X		X
21030	Golden Gate	V	I-580/US 101 Interchange improvements			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
21317	Golden Gate	V	Widen Rte 1 from US 101 to Flamingo Rd			X
22419	Golden Gate	V	Hwy 101 HOV lanes from Lucky Dr to N San Pedro Rd		X	X
22513	Golden Gate	V	SMART Commuter Rail		X	X
22002	Transbay Bay Bridge	N	Extend HOV lane on N I-880 from existing terminus at Bay Bridge approach to Maritime on-ramp			X
22626	North Bay East-West	C	Rte 29/Rt 37 interchange improvements	X		X
22899	North Bay East-West	C	Improve Rte 12 between Suisun City and Rio Vista			X
94073	North Bay East-West	N	Construct new S Rte 221 to S Rte 29 flyover	X		
94074	North Bay East-West	N	Widen Rte 12 (Jameson Canyon) from I-80 in Solano County to Rte 29 in Napa County to 4 lanes			X
94152	North Bay East-West	N	Widen Rte 12 (Jameson Canyon) from I-80 in Solano County to Rte 29 in Napa County to 4 lanes	X	X	
22746	Napa Valley	V	1st St overcross widening			X
22192	Sonoma Co-wide	V	Airport Blvd widening			X
22193	Sonoma Co-wide	V	Forestville bypass on Rte 116			X
22207	Sonoma	V	Extend Farmers Lane as a 3-or 4-lane arterial from Bellevue Ave to Rte 12	X		
98222	Delta	N	Rte 4 bypass, widen Rte 160 N freeway-to-freeway connectors			X
98999	Delta	N	Widen Rte 4 E to 8 lanes from Somersville Rd to SR 160	X		X
22604	Delta	V	Vasco Rd widening to 4 lanes from Brentwood to Alameda County		X	X
22605	Delta	V	SR4 Bypass, widen segments 2 & 3 and upgrade to full freeway			X
22668	Delta	V	HOV Lanes on I-680		X	X
22981	Delta	V	SR 4 Widening Marsh Creek Rd to San Joaquin County			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
98140	Sunol Gateway	C	I-680 Sunol Grade S HOV lanes and aux lane Rte 84 to Rte 237	X	X	X
98139	Sunol Gateway	N	ACE station/track improvements	X	X	X
22897	Sunol Gateway	N	Widen I-680 N for HOV lane Rte 84 to Calaveras Blvd	X	X	X
22624	Eastshore-North	C	Construct continuous 4-lane Jepson Parkway Reliever Route			X
22629	Eastshore-North	C	New Vallejo Ferry Terminal Intermodal Facility			X
22632	Eastshore-North	C	American Canyon Rd overpass expansion		X	
22986	Eastshore-North	C	Widen and improve Broadway between Hwy 37 to Mini Dr			X
94151	Eastshore-North	N	Jepson Parkway from Rte 12 to Leisure Town Rd			X
21209	Eastshore-North	N	Hercules Transit Center relocation			X
21210	Eastshore-North	N	Capitol Corridor train station in Hercules			X
21807	Eastshore-North	N	I-80/680/12 Interchange			X
22038	Eastshore-North	N	SFOBB Toll Plaza HOV Bypass Lanes			X
22700	Eastshore-North	N	Construct parallel corridor N of I-80 from Red Top Rd to Abernathy Rd	X		X
22898	Eastshore-North	N	Widen I-80 W of Meridian Rd to W of Kidwell Rd			X
21101	Eastshore-South	N	Tinker Ave extensions Webster to 5th			X
21185	Eastshore-South	N	Eden Rd extension			X
22764	Eastshore-South	N	I-880 improvements Hegenberger Rd and 66th Ave			X
22106	Eastshore-South	V	Whitesell St Extension			X
22660	Eastshore-South	V	I-880 widening between Whipple and Jackson			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
22670	Eastshore-South	V	Extend I-880 HOV lanes N of San Leandro and Oakland			X
22671	Eastshore-South	V	S I-880 to W SR 84 direct HOV connector			X
22353	Diablo	C	I-680 southbound HOV gap closure			X
98130	Diablo	N	Widen Alhambra Ave from Rte 4 to McAlvey Dr		X	X
98133	Diablo	N	Widen Pacheco Blvd from Blum Rd to Arthur Rd		X	
98194	Diablo	N	Extend Commerce Ave to Willow Pass Rd			X
98196	Diablo	N	Rte 24 E aux lanes		X	
21206	Diablo	N	Caldecott Tunnel fourth bore		X	
22602	Diablo	N	Construct I-680 aux lanes from Sycamore Valley Rd to Crow Canyon Rd	X	X	X
22351	Diablo	V	I-680 N HOV Gap Closure			X
22614	Diablo	V	Martinez Intermodal Station			X
22965	Diablo	V	US 101 Mabury Rd/Taylor St interchange construction			X
22785	Tri-Valley	C	Construct I-580 E aux lane from 1st St to Vasco Rd	X		
22796	Tri-Valley	C	Construct 4 lane arterial connection between N. Canyons Parkway and Dublin Blvd			X
22776	Tri-Valley	N	Widen Rte 84 to 4 lanes from N of Pigeon Pass to Vineyard Ave, 4 or 6 lanes from Vineyard Ave to Jack London Blvd	X	X	X
22013	Tri-Valley	N	I-580 corridor improvements	X	X	X
22664	Tri-Valley	V	I-580 HOT lanes from Greenville Rd W to I-680	X	X	X
22666	Tri-Valley	V	Rte 84 HOT lanes in Tri-Valley	X	X	X
22991	Fremont-South Bay	C	Widen I-680 for HOV/HOT lanes from Rte 237 to Rte 84		X	X
21132	Fremont-South Bay	N	BART extension to Warm Springs			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
22042	Fremont-South Bay	N	Widen I-680 for N HOV lane from Rte 237 to Stoneridge Dr	X	X	X
22062	Fremont-South Bay	N	Construct infrastructure for future Irvington BART Station	X		
22805	Fremont-South Bay	N	Dixon Landing Rd widening			X
22990	Fremont-South Bay	N	Reconstruct I-880/Rte 262 interchange			X
22668	Fremont-South Bay	V	I-680 HOV lanes /b/ Rte 84 in Alameda Co to Alcosta Blvd in Contra Costa Co	X		
22800	Fremont-South Bay	V	BART extension to Santa Clara County			X
22084	Alameda County	N	Air Cargo Access Rd			X
22823	Santa Clara County	N	Snell Ave widening			X
98103	Silicon Valley	N	SR 17 improvements, N SR 17 aux lane			X
98175	Silicon Valley	N	Widen Montague Expressway to 8 lanes from I-680 to US 101	X		X
21713	Silicon Valley	N	Construct aux lane on E Route 237 from N 1st St to Zanker Rd	X		
21714	Silicon Valley	N	SR 25/Santa Teresa Boulevard/US 101 IC Construction			X
21716	Silicon Valley	N	SR 237 widening for HOV lanes			X
21717	Silicon Valley	N	SR 25 upgrade to 6-Lane Design			X
21718	Silicon Valley	N	SR 85 aux lanes between Homestead Ave and Fremont Ave			X
21724	Silicon Valley	N	US 101 aux lane widening from Trimble Rd to Montague Expressway			X
22134	Silicon Valley	N	US 101 Southbound widening from Story Rd to Yerba Buena Rd			X
22138	Silicon Valley	N	Widen US 101 to 4 lanes from Rte 25 to Santa Clara/San Benito County	X		X
22140	Silicon Valley	N	US 101 widening between Cochrane Rd and Monterey Hwy			X
22153	Silicon Valley	N	Mathilda/SR 237 corridor improvements			X
22176	Silicon Valley	N	Berryessa Rd widening to 6 lanes			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
22177	Silicon Valley	N	Branham Lane Widening-Vista Park Drive to Snell Ave			X
22178	Silicon Valley	N	Calaveras Blvd overpass widening			X
22179	Silicon Valley	N	Central Expressway Improvements between Lawrence Expressway and San Tomas Expressway			X
22185	Silicon Valley	N	Oakland Road widening			X
22186	Silicon Valley	N	Widen San Tomas Expressway between Rte 82 and Williams Rd to 8 lanes	X		X
22422	Silicon Valley	N	Widen Senter Rd between Tully Rd and Capitol Expressway to 6 lanes	X		
22832	Silicon Valley	N	SR 152 Improvements			X
22834	Silicon Valley	N	SR 237 Eastbound Auxiliary Lane			X
22844	Silicon Valley	N	Right hand turn lane from W Monroe St to San Tomas Expressway			X
22845	Silicon Valley	N	US 101 Southbound Auxiliary Lane improvement			X
22857	Silicon Valley	N	Widen US 101 for a S aux lane from I-880 to McKee Rd/Julian St	X		X
22871	Silicon Valley	N	Uvas Park Drive Roadway extension			X
22881	Silicon Valley	N	Lawrence Expressway/SR 237 aux lane			X
22885	Silicon Valley	N	Los Gatos Creek Trail expansion			X
22886	Silicon Valley	N	McKean Rd. shoulder widening		X	X
22887	Silicon Valley	N	Moody Rd improvements			X
22888	Silicon Valley	N	King Rd Pedestrian improvements			X
22892	Silicon Valley	N	Widen US 101 S aux lane from Great America Pwy to Lawrence Expwy			X
22893	Silicon Valley	N	Widen US 101 for a N aux lane from McKee/Julian Street to I-880			X
21770	Silicon Valley	V	Caltrain extension to Salinas/Monterey			X
22017	Silicon Valley	V	SR 237 Eastbound to Mathilda Ave			X
22091	Silicon Valley	V	Upgrade Rte 152 to a 4-lane freeway	X		X
22127	Silicon Valley	V	Rte 85 N and S aux lanes from Stevens Creek Blvd to Saratoga/Sunnyvale Rd			X
22128	Silicon Valley	V	Rte 85 N and S aux lanes from Saratoga/Sunnyvale Rd to Saratoga Ave			X

Table 2.6-3: Projects Susceptible to Surface Fault Rupture, Landslides, or Liquefaction

Project ID	*Corridor*	*Investment**	*Description*	*Hazard*		
				SFR[a]	*LDS*[b]	*LIQ*[c]
22130	Silicon Valley	V	Rte 85 N and S aux lanes from Saratoga Ave to Winchester Blvd			X
22134	Silicon Valley	V	Widen US 101 southbound from Story Rd to Yerba Buena Rd	X		
22158	Silicon Valley	V	Rte 85 aux lanes between Fremont Ave and El Camino Real	X		X
22165	Silicon Valley	V	US 101 S to Rte 237 aux lane imprvts			X
22945	Silicon Valley	V	Aldercroft Creek Bridge/Old Santa Cruz Hwy		X	
22965	Silicon Valley	V	US 101 Mabury Rd/Taylor St imprvts			X

a SFR = Surface Fault Ruptre
b LDS = Landslides
c LIQ = Liquefaction

**C= Committed Project, N= New Commitment Projects, V= Vision Element Project*

2.7 Water Resources

This chapter analyzes the surface water and groundwater resources of the Bay Area in relation to the location of projects comprising the Transportation 2030 Plan. The potential effects of Transportation 2030 Plan on these resources are identified; and mitigation measures that may reduce those effects to a less-than-significant level are proposed.

ENVIRONMENTAL SETTING

PHYSICAL SETTING

Climate

Much of California enjoys a Mediterranean climate with cool, wet winters and warm, dry summers. Most of the region's moisture originates in the Pacific Ocean as high pressure shifts southward in the winter. The warm valley brings moisture from the ocean in the form of cooling fog to San Francisco in the summer. Climate within the Bay Area varies significantly depending on topographic conditions and proximity to the ocean. The coastal areas have mild, rainy winters and mild, foggy summers, while the inland areas experience more extreme variation between winter low and summer high temperatures. Annual rainfall in the Bay Area can range from 8 to 9 inches per year in the inland valleys to as much as 24 inches in the coastal hills and northern reaches of the region. Approximately 95 percent of annual precipitation in the Bay Area occurs between October and April, and flooding can occur in urban creeks and streams during more intense rainstorms.

Regional Physiography

The San Francisco Bay Delta system is generally regarded as the most important water system in California. Runoff from about 40 percent of the land in California (60,000 square miles) and 47 percent of the state's total streamflow drains from the Sacramento and San Joaquin Rivers into San Francisco Bay. More than 90 percent of runoff occurs during the winter and spring months from rainstorms and snow melt. San Francisco Bay encompasses approximately 1,600 square miles and is surrounded by the nine Bay Area counties. The drainage basin that contributes surface water flows directly to the Bay covers a total area of 3,464 square miles. The largest subbasins include Alameda Creek (695 square miles), the Napa River (417 square miles), and Coyote Creek (353 square miles). The San Francisco Bay estuary includes deep-water channels, tidelands, and marshlands that provide a variety of habitats for plants and animals. The salinity of the water varies widely as the landward flows of saline water and the seaward flows of fresh water converge near the Benicia Bridge. The salinity levels in the Central Bay can vary from near oceanic levels to one-quarter as much, depending on the volume of freshwater runoff.

Surface Waters

Surface waters in the Bay Area include freshwater rivers and streams, coastal waters, and estuarine waters. Estuarine waters include the San Francisco Bay Delta from the Golden Gate to the Sacramento and San Joaquin Rivers, and the lower reaches of various streams that flow directly into the Bay, such as the Napa and Petaluma Rivers in the North Bay and the Coyote and San Francisquito Creeks in the South Bay. Major water bodies in the Bay Area, including creeks and rivers, are presented in Figure 2.7-1.

Groundwater

Groundwater basins are closely linked to local surface waters. As water flows from the hills toward the Bay, it percolates through permeable soils into the groundwater basins. The primary groundwater basins in the Bay Area are the Petaluma Valley, Sonoma Valley, Suisun-Fairfield Valley, San Joaquin Valley, Clayton Valley, Diablo Valley, San Ramon Valley, Livermore Valley, and Santa Clara Valley basins. Groundwater in many regions of the Bay Area is utilized for numerous purposes, including municipal and industrial water supply.

Water Quality

The quality of regional surface water and groundwater resources is affected by point-source and nonpoint-source discharges throughout individual watersheds. Regulated point sources such as wastewater treatment effluent discharges usually involve a single discharge into receiving waters. Nonpoint sources involve diffuse and nonspecific runoff that enters receiving waters through storm drains or from unimproved natural landscaping. Common nonpoint sources include urban runoff, agricultural runoff, resource extraction (ongoing and historical), and natural drainage. Pollutants that enter water bodies in urban runoff include oil and gasoline by-products from parking lots, streets, and freeways. Copper from brake linings and lead from counterweights contribute heavy metals to local waters. In addition, impervious surfaces increase runoff quantities, taxing flow capacities of local flood control systems and deteriorating natural habitats.

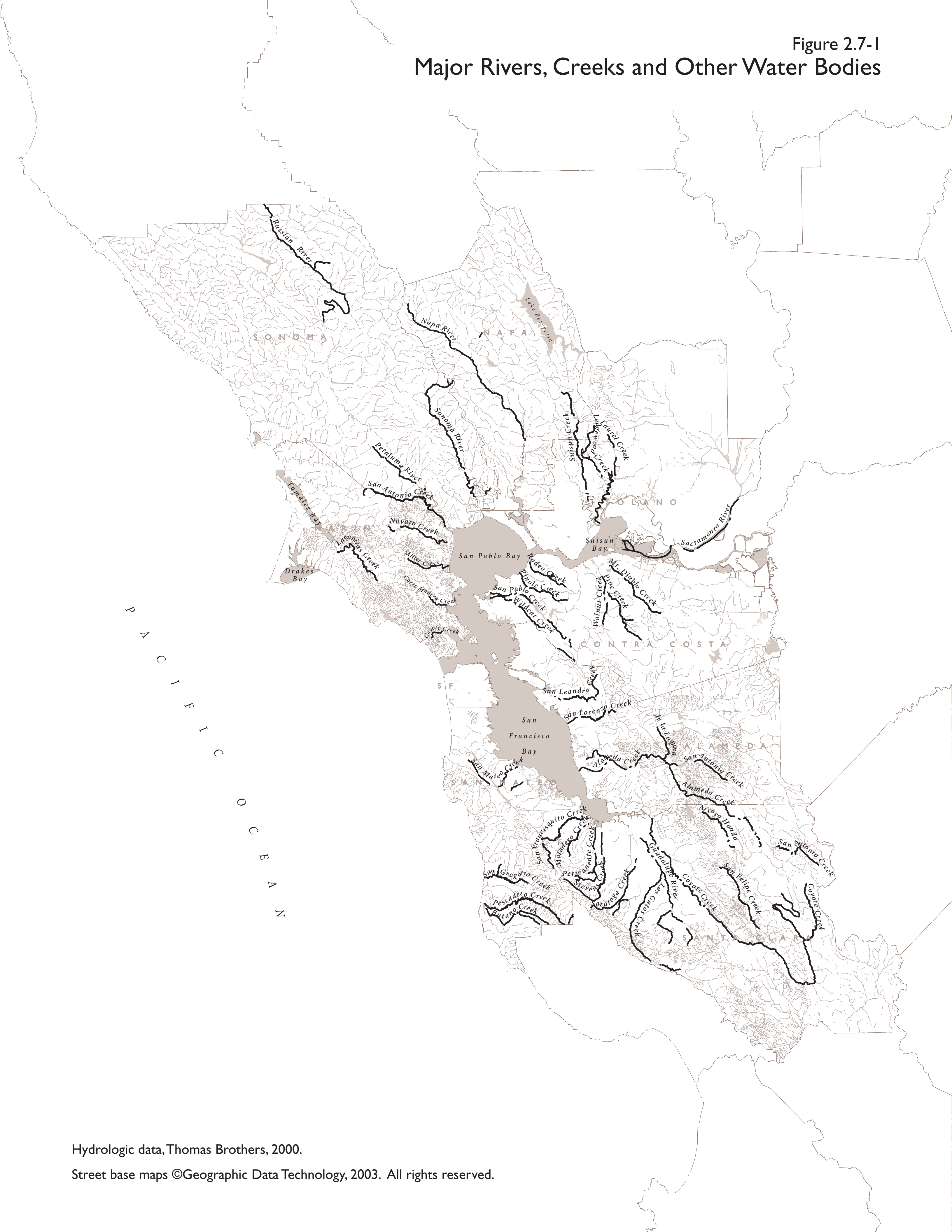
Regionally, stormwater runoff is estimated to contribute more heavy metals to the San Francisco Bay than direct municipal and industrial dischargers, as well as significant amounts of motor oil, paints, chemicals, debris, grease, and detergents. Runoff in storm drains may also include pesticides and herbicides from lawn care products and bacteria from animal waste. Most runoff flows untreated into creeks, lakes, and the Bay. As point sources of pollution have been brought under control, the regulatory focus has shifted to nonpoint sources, particularly urban runoff. Additional information regarding water quality in the Bay Area is provided in the regulatory setting, below.

Flood Hazards

Portions of the Bay Area are subject to flooding. The U.S. Congress passed the National Flood Insurance Act in 1968 and the Flood Disaster Protection Act in 1973 to restrict certain types of development on floodplains and to provide for a national flood insurance program. The purpose of these acts is to reduce the need for large, publicly funded flood control structures and disaster relief.

Figure 2.7-1

Major Rivers, Creeks and Other Water Bodies



Hydrologic data, Thomas Brothers, 2000.

Street base maps ©Geographic Data Technology, 2003. All rights reserved.

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program. The program provides subsidized flood insurance to communities that comply with FEMA regulations to limit development in floodplains. FEMA issues Flood Insurance Rate Maps for communities participating in the National Flood Insurance Program. Figure 2.7-2 identifies federally designated flood hazard zones in the Bay Area.

FEMA classifies flood hazard zones as follows:

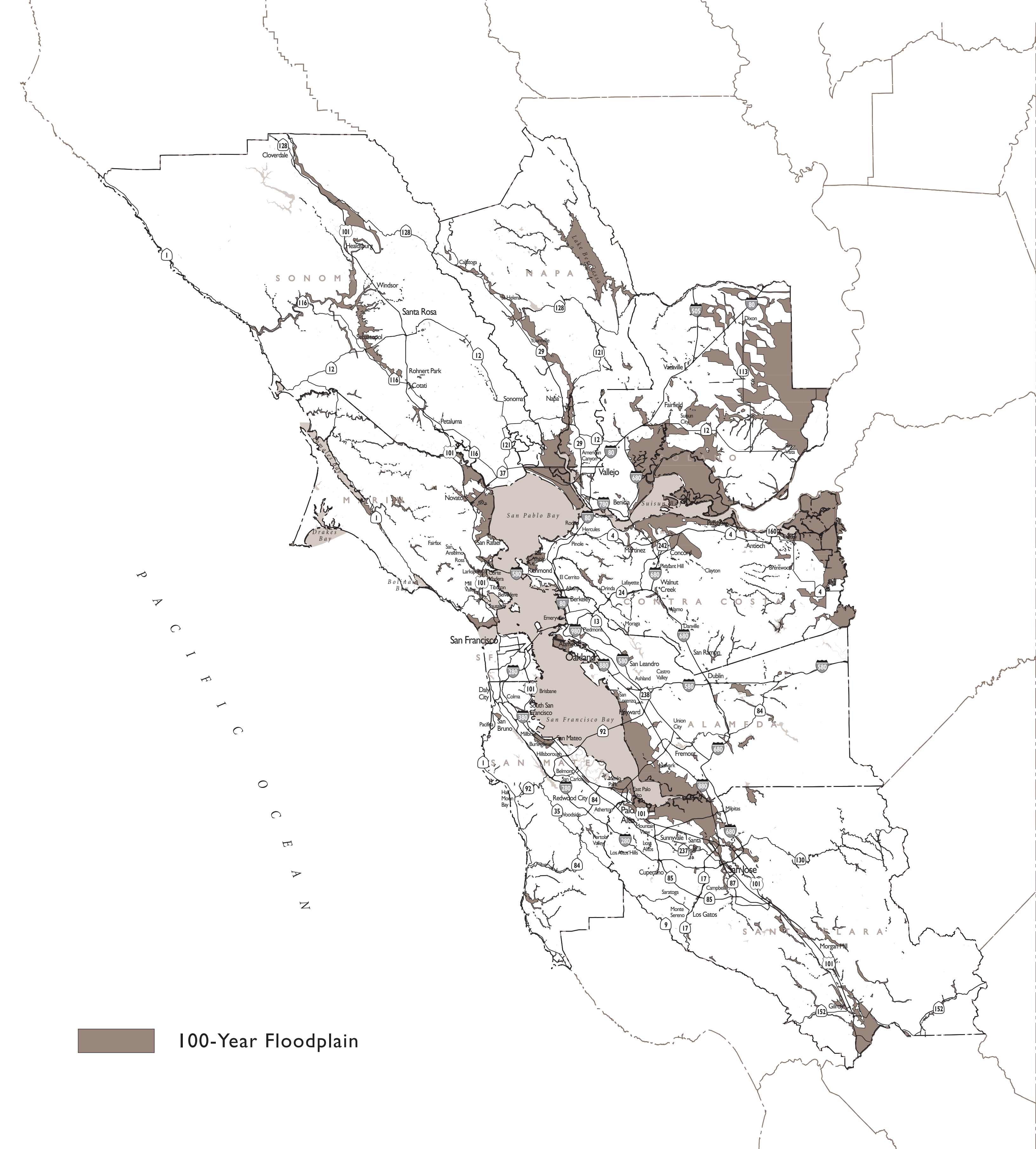
- *Zone A.* Flood insurance rate zone that corresponds to the 100-year floodplain, determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
- *Zone B, C, and X.* Flood insurance rate zones that correspond to areas outside the limits of the 100-year floodplains; areas subject to 100-year sheet-flow flooding with average depth of less than 1 foot; areas of 100-year stream flooding where the contributing drainage area is less than one square mile; or areas protected from the 100-year flood by levees from the base flood. No base flood elevations or depths are shown within this zone.
- *Zone D.* Flood insurance rate zones that correspond to areas where there are possible but undetermined flood hazards. No analysis of flood hazards has been conducted. Mandatory flood insurance purchase requirements do not apply, but coverage is available. Flood insurance rates within Zone D are commensurate with the uncertainty of the flood hazard.

Many local jurisdictions regulate development within floodplains. Construction standards are established within local ordinances and planning elements to reduce flood impedance, safety risks, and property damage. Historic floods in the Bay Area have been devastating. In response, local flood control agencies and the U.S. Army Corps of Engineers have established extensive flood control projects, including dams and improved channels. Concrete and riprap levees and river bottoms have significantly reduced riparian habitats throughout the region.

REGULATORY SETTING

Regulatory authorities exist on both the state and federal levels for the control of water quality in California. The major federal legislation governing the water quality aspects of the project is the Clean Water Act, as amended by the Water Quality Act of 1987. The objective of the act is “to restore and maintain the chemical, physical, and biological integrity of the nation’s waters.” The State of California’s Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code) provides the basis for water quality regulation within California. The State Water Resources Control Board (SWRCB) administers water rights, water pollution control, and water quality functions throughout the state, while the Regional Water Quality Control Boards (RWQCBs) conduct planning, permitting, and enforcement activities.

Figure 2.7-2
Flood Hazard Area



100-Year Floodplain

Floodplain data, FEMA, 1997.

Street base maps ©Geographic Data Technology, 2003. All rights reserved.

California State Water Resources Control Board and Regional Water Quality Control Boards

The primary responsibility for the protection and enhancement of water quality in California has been assigned by the California legislature to the SWRCB and the nine RWQCBs. The SWRCB provides state-level coordination of the water quality control program by establishing statewide policies and plans for the implementation of state and federal laws and regulations. The RWQCBs adopt and implement water quality control plans that recognize the unique characteristics of each region with regard to natural water quality, actual and potential beneficial uses, and water quality problems. The Bay Area encompasses portions of four separate RWQCBs: the North Coast Region, Central Coast Region, San Francisco Bay Region, and the Central Valley Region.

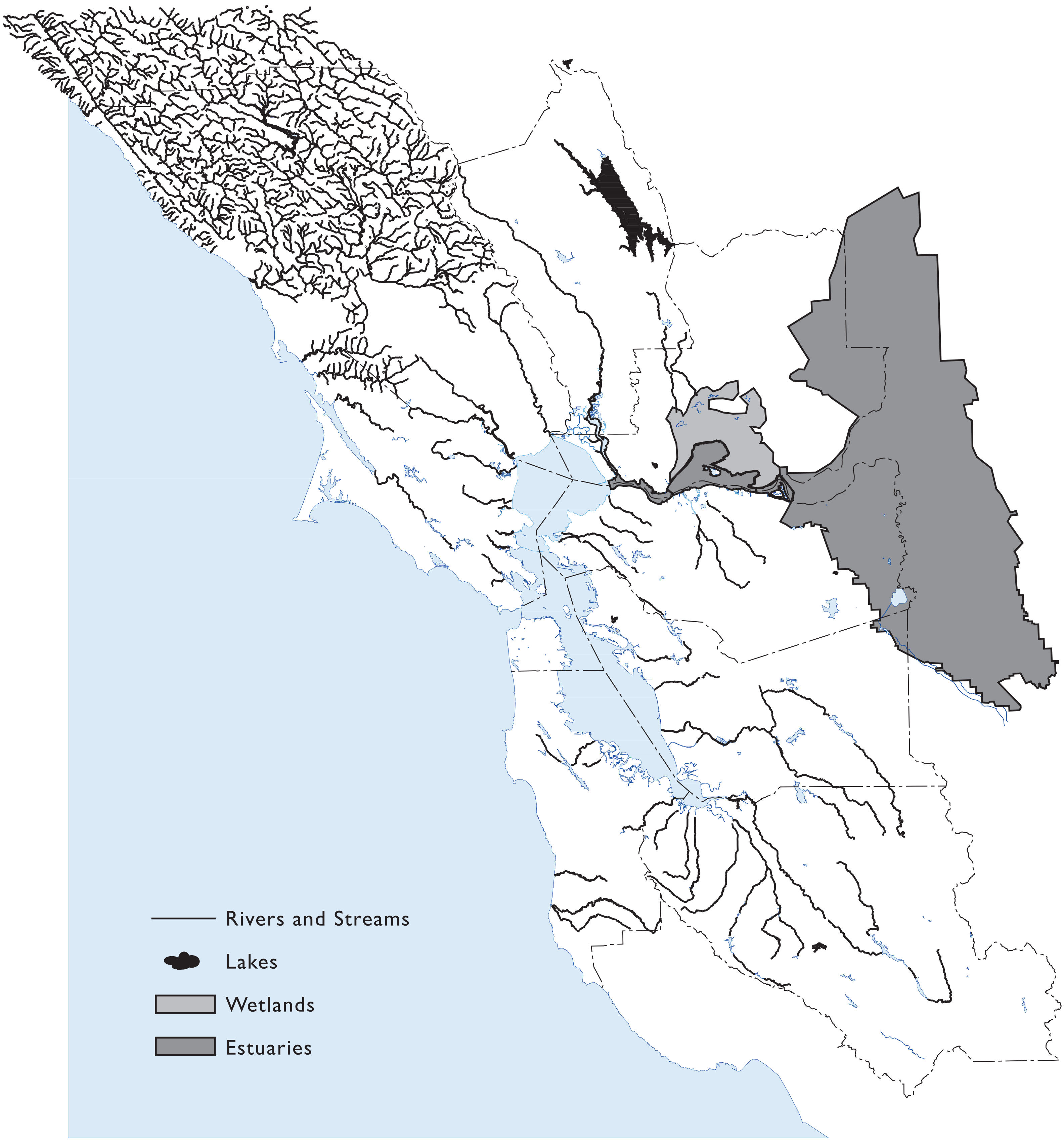
Both the SWRCB and U.S. Environmental Protection Agency (U.S. EPA) Region IX have been in the process of developing new water quality objectives and numeric criteria for toxic pollutants for California surface waters since 1994, when a State court overturned the SWRCB's water control plans containing water quality criteria for priority toxic pollutants. U.S. EPA's California Toxics Rule (CTR) was promulgated on May 18, 2000. The new criteria largely reflect the existing criteria contained in U.S. EPA's 304(a) Gold Book (1986) and its National Toxics Rule (NTR) adopted in December 1992 [57 Federal Register 60848], and those of earlier state plans (the Inland Surface Waters Plan and the Enclosed Bays and Estuaries Plan of April 1991, since rescinded). With promulgation of the Final CTR, these federal criteria are legally applicable in the State of California for inland surface waters, enclosed bays and estuaries for all purposes and programs under the Clean Water Act.

Section 303d of the Clean Water Act - Total Maximum Daily Load (TMDL)

California has identified waters that are polluted and need further attention to support their beneficial uses. These water bodies are listed pursuant to Clean Water Act Section 303(d), which requires States to identify these polluted waters. Specifically, Section 303(d) requires that each state identify water bodies or segments of water bodies that are "impaired" (i.e., not meeting one or more of the water quality standards established by the state). Approximately 500 water bodies or segments have been listed in California. Once the water body or segment is listed, the state is required to establish "Total Maximum Daily Load," or TMDL, for the pollutant causing impairment. The TMDL is the quantity of a pollutant that can be safely assimilated by a water body without violating water quality standards. Listing a water body as impaired does not necessarily suggest that the pollutants are at levels considered hazardous to humans or aquatic life or that the water body segment cannot support the beneficial uses. The intent of the 303(d) list is to identify the water body as requiring future development of a TMDL to maintain water quality and reduce the potential for continued water quality degradation. TMDLs have yet to be determined for most of the identified impaired water bodies, although a priority schedule has been developed to complete the process in the region by 2012. The RWQCBs are responsible for developing strategies to attain compliance with the designated TMDLs. Many tributaries to and portions of San Francisco Bay and the Sacramento–San Joaquin Delta are listed as impaired water bodies on California's 303(d) list and could be adversely affected by pollutants and other stressors that affect water quality. Figure 2.7-3 shows the location of Section 303(d) impaired water bodies in the Bay Area.

Figure 2.7-3

Impaired Water Bodies



National Pollutant Discharge Elimination System

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to regulate discharges into "navigable waters" of the United States. The RWQCBs monitor and enforce NPDES construction stormwater permitting in the Bay Area. The SWRCB administers the NPDES Permit Program through its General NPDES Permit. Construction activities of one acre or more are subject to the permitting requirements of the NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction Activity (General Construction Permit). The project sponsor must submit a Notice of Intent to the SWRCB in order to be covered by the General Permit prior to the beginning of construction. The General Construction Permit requires the preparation and implementation of a stormwater pollution prevention plan (SWPPP), which must be prepared before construction begins. Components of SWPPPs typically include specifications for best management practices (BMPs) to be implemented during project construction for the purpose of minimizing the discharge of pollutants in stormwater from the construction area. In addition, a SWPPP includes measures to minimize the amount of pollutants in runoff after construction is completed, and identifies a plan to inspect and maintain project BMPs and facilities.

The 1987 Clean Water Act Amendments also requires municipalities and unincorporated communities to obtain NPDES permit coverage in order to control urban stormwater runoff. Municipal NPDES permits require the development and implementation of Storm Water Management Plans (SWMP), which include measures to reduce pollutants in stormwater to the maximum extent possible. Typical components of a SWMP include the identification of BMPs to reduce stormwater pollutant from new developments, both during and after completion construction activities, and identification of measures to control increases in stormwater runoff resulting from development. Municipal stormwater permitting within the Bay Area is typically organized by county, as individual cities, towns, and unincorporated regions have joined together to better organize and coordinate stormwater management.

Sections 401 and 404 of the Clean Water Act

The RWQCBs coordinate the State Water Quality Certification Program, or Section 401 of the Clean Water Act. Under Section 401, states have the authority to review any permit or license that will result in a discharge or disruption to wetlands and other waters under state jurisdiction, to ensure that the actions are consistent with the state's water quality requirements. This program is most often associated with Section 404 of the Clean Water Act, which obligates the U.S. Army Corps of Engineers to issue permits for the movement of dredge and fill material into and from "waters of the United States." Additionally, Section 404 requires permits for activities that affect wetlands or alter hydrologic features, such as wetlands, rivers, or ephemeral creek beds.

IMPACT ANALYSIS

CRITERIA OF SIGNIFICANCE

This EIR uses the following criteria to assess whether proposed improvements in the proposed Transportation 2030 Plan would have a significant adverse effect on water resources:

- **Criterion 1: Erosion from cut-and-fill slopes.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects increase erosion by altering the existing drainage patterns of the site that contributes to sediment loads of streams and drainage facilities, thereby affecting water quality.
- **Criterion 2: Pollution of stormwater runoff from vehicle residues.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects increase non-point pollution of stormwater runoff due to litter, fallout from airborne particulate emissions, or discharges of vehicle residues, including petroleum hydrocarbons, and metals, that would impact the quality of receiving waters.
- **Criterion 3: Pollution of stormwater runoff from construction sites.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects result in pollution of stormwater runoff from construction sites due to discharges of sediment, chemicals, and wastes to nearby storm drains and creeks.
- **Criterion 4: Increased rates and amounts of runoff from impervious surfaces.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects result in increased rates and amounts of runoff due to additional impervious surfaces, higher runoff values for cut-and-fill slopes, or alterations to drainage systems that could cause potential flood hazards and effects on water quality.
- **Criterion 5: Reduced rates of groundwater recharge.** Implementation of the proposed Transportation 2030 Plan would have a potentially significant impact if transportation projects reduce rates of groundwater recharge due to the increased amount of impervious surfaces.

Potential effects on water resources would vary depending on the type and scale of the project, the location of the project relative to drainage facilities and water bodies, and the sensitivity of the receiving facility or water body.

METHOD OF ANALYSIS

Impacts are determined for the proposed Transportation 2030 Plan as a whole and for specific projects involving new construction. Projects which do not include the construction of infrastructure, such as bus line schedules or routes, local road maintenance, wheelchair curb ramps, or traffic light coordination would utilize existing transportation infrastructure and would not increase impervious surface area or alter groundwater recharge patterns. Potential changes to short or long-term quality of stormwater runoff originating from these facilities are therefore negligible. In contrast, other projects in the Transportation 2030 Plan would include the construction or expansion of interchanges, roadways, high occupancy lanes, bridges, tunnels, parking lots, or transit facility buildings. The creation of new impervious surfaces associated with these construction projects and the subsequent changes to the quality and volume of storm water runoff could result in water quality impacts. Some of these projects, based upon their location relative to surface water bodies, 100-year floodplains, and impaired water bodies, may potentially result in more significant hydrologic impacts. Due to the scale of these maps, this analysis is based upon generalized potential impacts and does not satisfy the need for site-specific surveys for individual projects.

SUMMARY OF IMPACTS

Project-specific studies could be necessary to determine the actual potential for significant impacts on hydrology and water quality resulting from implementation of transportation improvements in the Transportation 2030 Plan. However, some general impacts can be identified based on the nature of the individual transportation improvements. As noted, projects located in flood hazard areas, adjacent to water bodies, or those in which runoff drains to impaired water bodies are most likely to affect water resources.

Direct Impacts

Implementation of transportation improvements in the Transportation 2030 Plan could result in both short term and long term impacts on water resources.

Short-term impacts are temporary and generally related to construction activities, which could result in erosion and sedimentation effects on water bodies. Long-term effects are related to the intensification of regional urban uses associated with the expansion of roadways and other proposed transportation improvements, creating more impervious surfaces. Runoff from transportation facilities could increase nonpoint-source pollutant concentrations in stormwater regionally, as well as in groundwater basins. The paving required for highway projects could also decrease the amount of surface water that filters into the ground. In addition to water quality impacts, the Transportation 2030 Plan may also affect flooding, as increased runoff associated with paving may contribute to downstream flooding hazards and some projects are located in 100-year flood hazard areas.

Indirect/Cumulative Impacts

Indirect and cumulative impacts on water resources are associated with future planned urban development combined with transportation improvements that could have the potential to impact water quality, alter drainage patterns, create higher erosion rates and reduce groundwater recharge.

IMPACTS & MITIGATION

Impact

2.7-1 Construction of the proposed transportation improvements in the Transportation 2030 Plan could adversely affect water quality and drainage patterns in the short term due to erosion and sedimentation. ***(Significant, mitigable)***

Construction activities undertaken to implement transportation improvements in the proposed Transportation 2030 Plan could include excavation, soil stockpiling, boring, and/or grading activities that create bare slopes as existing vegetation is stripped prior to the installation of impervious surfaces. Soil erosion is probable during construction and resulting water quality problems could include turbidity, increased algal growth, oxygen depletion, or sediment buildup thereby degrading aquatic habitats. Sediment from project-induced erosion could also accumulate in downstream drainage facilities and interfere with stream flow, thereby aggravating downstream flooding conditions.

Depending on the transportation project location, impacts from construction could affect local storm drain catch basins, culverts, flood control channels, streams, and San Francisco Bay. Most runoff in urban areas is eventually directed to either a storm drain or water body, unless allowed to stand in a detention area and filter into the ground. For this reason, even projects not directly adjacent to or crossing a sensitive area could have an impact.

Mitigation Measures

Project sponsors shall commit to mitigation measures at the time of certification of their project environmental document. These commitments obligate project sponsors to implement measures that would minimize or eliminate any significant impacts on water resources.

2.7(a) Local permitting agencies shall require preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP), in accordance with the SWRCB's General Construction Permit. The SWPPP shall also be consistent with the Manual of Standards for Erosion and Sedimentation Control by the Association of Bay Area Governments, the California Stormwater Quality Association (CASQA), Stormwater Best Management Practice Handbook for Construction, policies and recommendations of the local urban runoff program (city and/or county), and the recommendations of the RWQCB. Implementation of the SWPPP shall be enforced by inspecting agencies during the construction period via appropriate options such as citations, fines, and stop-work orders. Typical components of a SWPPP would include the following:

- Excavation and grading activities shall be scheduled for the dry season only (April 15 to October 15), to the extent possible. This will reduce the chance of severe erosion from intense rainfall and surface runoff, as well as the potential for soil saturation in swale areas.
- If excavation occurs during the rainy season, storm runoff from the construction area shall be regulated through a stormwater management/erosion control plan that may in-

clude temporary on-site silt traps and/or basins with multiple discharge points to natural drainages and energy dissipaters. Stockpiles of loose material shall be covered and runoff diverted away from exposed soil material. If work is stopped due to rain, a positive grading away from slopes shall be provided to carry the surface runoff to areas where flow can be controlled, such as the temporary silt basins. Sediment basin/traps shall be located and operated to minimize the amount of offsite sediment transport. Any trapped sediment should be removed from the basin or trap and placed at a suitable location on-site, away from concentrated flows, or removed to an approved disposal site.

- Temporary erosion control measures shall be provided until perennial revegetation or landscaping is established and can minimize discharge of sediment into nearby waterways. For construction within 500 feet of a water body, fiber rolls and/or gravel bags shall be placed upstream adjacent to the water body.
- After completion of grading, erosion protection shall be provided on all cut-and-fill slopes. Revegetation should be facilitated by mulching, hydroseeding, or other methods and shall be initiated as soon as possible after completion of grading and prior to the onset of the rainy season (by October 15).
- Permanent revegetation/landscaping shall emphasize drought-tolerant perennial ground coverings, shrubs, and trees to improve the probability of slope and soil stabilization without adverse impacts to slope stability due to irrigation infiltration and long-term root development.
- BMPs selected and implemented for the project shall be in place and operational prior to the onset of major earthwork on the site. The construction phase facilities shall be maintained regularly and cleared of accumulated sediment as necessary.
- Hazardous materials such as fuels and solvents used on the construction sites shall be stored in covered containers and protected from rainfall, runoff, and vandalism. A stockpile of spill cleanup materials shall be readily available at all construction sites. Employees shall be trained in spill prevention and cleanup, and individuals should be designated as responsible for prevention and cleanup activities.

SWPPP(s) for projects immediately adjacent to or within drainages would also incorporate the following additional erosion control minimum criteria:

- Construction equipment shall not be operated in flowing water, except as may be necessary to construct crossings or barriers.
- Stream diversion structures shall be designed to preclude accumulation of sediment. If this is not feasible, an operation plan should be developed to prevent adverse downstream effects from sediment discharges.
- Where working areas are adjacent to or encroach on live streams, barriers shall be constructed that are adequate to prevent the discharge of turbid water in excess of specified limits. The discharged water shall not exceed 110 percent of the ambient stream turbidity of the receiving water, if the receiving water is a flowing stream with turbidity greater than 50 nephelometric turbidity unit (NTU), or 5 NTU above ambient turbidity for ambient

turbidities that are less than or equal to 40 NTU. If the water is discharged to a dry streambed, the discharged water shall not exceed 50 NTU.

- Material from construction work shall not be deposited where it could be eroded and carried to the stream by surface runoff or high stream flows.
- Riparian vegetation shall be removed only when absolutely necessary.

These mitigation measures would be expected to reduce this potentially significant impact on water resources to a less-than-significant level if incorporated by project sponsors.

Impact

2.7-2 The transportation improvements in the Transportation 2030 Plan could adversely affect water resources in the long term by reducing permeable surfaces, which could result in additional runoff and erosion, degrade water quality in receiving waters, decrease groundwater recharge, or alter drainage patterns. ***(Significant, mitigable)***

The proposed Transportation 2030 Plan would result in the expansion or reconfiguration of roadways, creation of parking lots, construction of transit facilities, overall addition of impervious surface areas, and use of landscaping related pesticides, herbicides, and fertilizers associated with maintenance of vegetation bordering roadways. Urban runoff can carry a variety of pollutants, such as oil and grease, metals, sediment, and pesticide residues from roadways, parking lots, rooftops, landscaped areas, and other surfaces, and deposit them in adjacent waterways. Pollutant concentrations in urban runoff are extremely variable and are dependent on storm intensity, land use, elapsed time between storms, and the volume of runoff generated in a given area that reaches receiving waters. The most critical time for urban runoff effects is in autumn under low flow conditions. Pollutant concentrations are typically highest during the first major rainfall event after the dry season, known as the "first flush."

Because the proposed Transportation 2030 Plan would increase the area of paved surfaces (roads, transit stations, park and ride lots, etc.), construction of the proposed projects combined with increased overall regional traffic could increase nonpoint-source pollutant concentrations in stormwater regionally. These nonpoint source pollutants could include oil and grease, petroleum hydrocarbons, and metals that would be transported by stormwater runoff to receiving water bodies. The paving required for highway projects could also have minor effects on the amount of surface water that filters into the ground, and groundwater basins could be affected by pollutants in the runoff from proposed transportation facilities.

In addition to potential water quality impacts, the proposed Transportation 2030 Plan may also affect flooding. Floodplains are areas that are periodically inundated during high flows of nearby streams or high water levels in ponds or lakes. Natural floodplains offer wildlife and plant habitat, open space, and groundwater recharge benefits. Project construction could affect these floodplain values, including potentially redirecting flood waters, if not mitigated. Proposed transportation improvements that are directly adjacent to or cross a drainage facility or water body, or are located in 100-year flood hazard areas would have a greater potential impact on water resources than projects further from drainage facilities, water bodies, or 100-year flood hazard areas. Proposed projects within a 100-year flood hazard area are listed in Table 2.7-1 at the end of this chapter. Flood hazard areas are shown in Figure 2.7-2.

Mitigation Measures

Project sponsors shall commit to mitigation measures at the time of certification or approval of project-related environmental documents. These commitments would obligate project sponsors to implement measures to minimize or eliminate any significant impacts on water resources.

2.7(b) Local permitting agencies shall require projects to comply with design guidelines established in the Bay Area Stormwater Management Agencies Association's (BASMAA) *Start at the Source Design Guidance Manual for Stormwater Quality Protection* and the California Storm Water Best Management Practice Handbook for New Development and Redevelopment to minimize both increases in the volume and rate of stormwater runoff, and the amount of pollutants entering the storm drain system. Typical mitigation measures shall include the following:

Surface Water

- Drainage of roadway and parking lot runoff shall, wherever possible, be designed to run through grass median strips, contoured to provide adequate storage capacity and to provide overland flow, detention, and infiltration before it reaches culverts. Detention basins and ponds, aside from controlling runoff rates, can also remove particulate pollutants through settling. Facilities such as oil and sediment separators or absorbent filter systems shall therefore be designed and installed within the storm drainage system to provide filtration of stormwater prior to discharge and reduce water quality impacts whenever feasible. For example, runoff shall be filtered through mechanical or natural filtration systems such as pre-manufactured oil water separators or through natural processes such as bioswales and settlement ponds to remove oil and grease prior to discharge.
- Long-term sediment control shall include an erosion control and revegetation program designed to allow reestablishment of native vegetation on slopes in undeveloped areas.
- In areas where habitat for fish and other wildlife would be threatened by transportation facility discharge, alternate discharge options shall be sought to protect sensitive fish and wildlife populations. Maintenance activities over the life of the project should include heavy-duty sweepers, with disposal of collected debris in sanitary landfills to effectively reduce annual pollutant loads where appropriate. Catch basins and storm drains shall be cleaned and maintained on a regular basis.
- Landscaped areas shall use Integrated Pest Management techniques (methods that minimize the use of potentially hazardous chemicals for landscape pest control and vineyard operations). The handling, storage, and application of potentially hazardous chemicals shall take place in accordance with all applicable laws and regulations.

Groundwater

- Detention basins, infiltration strips, and other features to facilitate groundwater recharge shall be incorporated into the design of new freeway and roadway facilities whenever possible.

Flooding

- Projects shall be designed so that they do not increase downstream flooding risks by increasing peak runoff volumes. Including detention ponds in designs for roadway medians, parking areas, or other facilities, or increasing the size of local flood control facilities serving the project areas could achieve this measure. Existing pervious surface shall be preserved to the maximum extent possible to minimize increases in stormwater runoff volumes and rates.
- Projects shall be designed to allow lateral transmission of stormwater flows across transportation corridors with no increased risk of upstream flooding. Culverts and bridges shall be designed to adequately carry drainage waters through project sites. The bottom of overpass structures should be elevated at least 1 foot above the 100-year flood elevation at all stream and drainage channel crossings.
- All roadbeds for new highway and rail transit facilities should be elevated at least 1 foot above the 100-year base flood elevation.

Effective integration of available mitigation measures would be expected to reduce this potentially significant impact on water resources to a less-than-significant level if incorporated by project sponsors.

Cumulative Impact

2.7-3 Forecast urban development that would be served by transportation improvements in the proposed Transportation 2030 Plan, combined with new public and private infrastructure improvements to accommodate future planned urban development, could create degrade regional water quality, reduce groundwater recharge, or result in increased flooding. ***(Significant, mitigable)***

Implementation of transportation improvements in the proposed Transportation 2030 Plan could result in indirect impacts on water resources by accommodating future planned urban development that could, when it occurs, have the potential to significantly impact water quality and alter drainage patterns. In addition, the combination of the transportation improvements in the Transportation 2030 Plan and new public and private infrastructure improvements serving future planned urban development could create higher erosion rates and reduced groundwater recharge.

Mitigation Measures

As the cumulative impacts of the transportation improvements in the Transportation 2030 Plan are the same as the direct impacts listed above, the mitigation measures for this impact would be the same as Measures 2.7(a) and 2.7(b). These mitigation measures would be expected to reduce this potentially significant cumulative impact to a less-than-significant level if incorporated by project sponsors.

Table 2.7-1: Projects Located Within a 100-Year Floodplain

Project ID	*Corridor*	*Investment**	*Description*
22604	Delta	V	Vasco Rd safety and operational improvements from Brentwood to Alameda Co line
22605	Delta	V	Rte 4 Bypass, Widen Segments 2 & 3 and upgrade to full fwy
22668	Delta	V	Add I-680 HOV lanes (Route 84 to Alcosta Boulevard)
22981	Delta	V	Route 4 Widening-Marsh Creek Road to San Joaquin Co.
98222	Delta	N	Rte 4 Bypass, Segment 1: Rte 160 fwy-to-fwy connectors
98999	Delta	N	Widen Rte 4 E. from 4 to 8 lanes, Somersville Rd to Rte 160
22353	Diablo	C	I-680 SB HOV gap closure between N Main Street and Livorna
98130	Diablo	N	Widen Alhambra Ave from Route 4 to McAlvey Drive
98133	Diablo	N	Widen Pacheco Blvd to 4 lanes from Blum Rd to Arthur Rd
22624	Eastshore-North	C	Jepson Pwy-construct 4 ln from Rte 12 to Leisure Town Rd
22986	Eastshore North	C	Broadway widening: Hwy 37 to Mini Drive
22629	Eastshore-North	C	New Vallejo Ferry Terminal intermodal facility
22700	Eastshore-North	N	I-80 No. Connector: construct a parallel corridorN of I-80
22898	Eastshore-North	N	I-80 Widen to 8 lanes (Meridian Rd. to Kidwell Rd.)
94151	Eastshore-North	N	Jepson Pwy-construct 4 lanes from Rte 12 to Leisure Town Rd
21101	Eastshore-South	N	Tinker Avenue Extensions: Webster to 5th
22670	Eastshore-South	V	Extend I-880 HOV lanes north to San Leandro and Oakland
22991	Fremont-So. Bay	C	Widen I-680 for HOV/HOT lane from Route 237 to Route 84
21132	Fremont-So. Bay	N	BART extension to Warm Springs
22042	Fremont-So. Bay	N	Widen I-680, northbound HOV, Route 247 to Stoneridge Dr
22800	Fremont-So. Bay	V	BART extension to Santa Clara County
22805	Fremont-So. Bay	N	Dixon Landing Road Widening
22990	Fremont-So. Bay	N	Phase 1B: reconstruct I-880/Rte 262 I/C and widen I-880 from Rte 262 to the Santa Clara Co line to 10 lanes
21030	Golden Gate	V	I-580/US 101 I/C impvts and new fwy-to-fwy connectors
22204	Golden Gate	V	Fulton Road Improvements
21317	Golden Gate	V	Route 1 from US 101 to Flamingo Road
22419	Golden Gate	V	Widen US 101 for HOV lns from lucky D to N San Pedro Rd
22513	Golden Gate	V	SMART Commuter Rail
22655	Golden Gate	C	Widen US 101 for HOV, Rohnert Park Exp. to Santa Rosa Ave
98154	Golden Gate	N	Widen US 101 from 4 lanes to 6 lanes
94074	North Bay E-W	N	Widen Route 12 to 4 Lanes
22626	North Bay E-W	C	Routes 29/37 Interchange
22899	North Bay E-W	C	Operational and Safety Improvements Rte 12 between Suisun

Table 2.7-1: Projects Located Within a 100-Year Floodplain

Project ID	*Corridor*	*Investment**	*Description*
			City and Rio Vista
21604	Peninsula	V	US 101 auxiliary lanes from Sierra
21619	Peninsula	N	Caltrain express tracks
21713	Silicon Valley	N	Construct aux ln on EB Rte 237 from N First St to Zanker Rd
21717	Silicon Valley	N	SR 25 Upgrade to 6-Lane Facility Design
21718	Silicon Valley	N	Rte 85 NB and SB aux lanes between Homestead Ave and Fremont Ave
21724	Silicon Valley	N	Widen US 101 for NB and SB aux lane from Trimble Rd to Montague Expwy
21749	Silicon Valley	N	Butterfield Blvd. Extension, Tennant Ave to Watsonville Rd
21770	Silicon Valley	V	Caltrain Extension to Salinas/Monterey
22012	Silicon Valley	V	Rte 237 eastbound aux le impvt from N First St to Zanker Rd
22091	Silicon Valley	V	Upgrade Route 152 to a limited access 4-lane freeway
22140	Silicon Valley	N	US 101 Widening between Cochrane Rd and Monterey Hwy
22145	Silicon Valley	N	SR 237 WB to NB US 101 Connector Ramp and Aux Ln Improvements
22158	Silicon Valley	V	Route 85 aux lns between Fremont Ave and El Camino Real
22175	Silicon Valley	N	Almaden Expwy Widening Between Coleman Ave and Blossom Hill Rd to 8 lanes
22176	Silicon Valley	N	Berryessa Rd Widening to 6 lns from I-680 to Commercial St
22178	Silicon Valley	N	Calaveras Blvd Overpass Widening
22179	Silicon Valley	N	Central Expswy impvts /b/ Lawrence Expwy and Mary Ave.
22185	Silicon Valley	N	Oakland Road Widening
22186	Silicon Valley	N	San Tomas Expwy widening /b/ SR82 and Williams Rd to 8 lns
22832	Silicon Valley	N	Route 152 Improvements, Traffic Signal at Gilroy Foods/WTI Intersection
22844	Silicon Valley	N	San Tomas Expressway at Monroe Street
22857	Silicon Valley	N	US 101 Southbound Auxiliary Lane Widening
22871	Silicon Valley	N	Uvas Park Drive Roadway Extension
22885	Silicon Valley	N	Los Gatos Creek Trail expansion on west side
22886	Silicon Valley	N	McKean Rd. shoulder widening and treatments
22892	Silicon Valley	N	Widen US 101 SB aux lane from Great America Parkway to Lawrence Expressway
22893	Silicon Valley	N	Widen US 101, northbound lane, McKee/Julian Street to I-880
22945	Silicon Valley	V	Aldercroft Creek Bridge/Old Santa Cruz Hwy.
22960	Silicon Valley	V	Almaden Road Improvements-Malone to Curtner
22965	Silicon Valley	V	US 101/Mabury Road/Taylor Street interchange construction
22983	Silicon Valley	V	US 101/Zanker Road/Skyport Drive/Fourth Street interchange
98103	Silicon Valley	N	Construct auxiliary lane on NB Rte 17 from Camden Ave to Hamilton Ave
98175	Silicon Valley	N	Widen Montague Expressway from 6 lanes to 8 lanes
22897	Sunol Gtwy.	N	I-680 HOV lane: Calavera Boulevard
98139	Sunol Gtwy.	N	ACE station/track improvements in Alameda County

Table 2.7-1: Projects Located Within a 100-Year Floodplain

Project ID	*Corridor*	*Investment**	*Description*
98140	Sunol Gtwy.	C	I-680 Sunol Grade SB HOV lanes, ramp metering and auxiliary lane from Route 84 to Route 237
22013	Tri-Valley	N	I-580 corridor improvements
22664	Tri-Valley	V	I-580 High Occupancy Toll Lanes
22666	Tri-Valley	V	Route 84 High Occupancy Toll Lanes in Tri-Valley
22776	Tri-Valley	N	Route 84 Expressway Widening

**C=Committed Project, N=New Commitment Project, V=Vision Element Project*